GEORGIA INSTITUTE OF TECHNOLOGY | OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. E-27-627 GTRI/GIT DATE 10 / 07 / 83

Project Director: Wayne Tincher School/Lab Textile Engineering

Sponsor: U.S. Department of Commerce
Washington, D.C. 20230

Type Agreement: Cooperative Agreement No. 99-26-07169-30 + Amendment 1

Award Period: From 10/1/83 To 1/31/85 (Performance) 4/30/85 (Reports)

Sponsor Amount:

	This Change	Total to Date
Estimated:	$	$ 196,077
Funded:	$	$ 196,077

Cost Sharing Amount: $ ______ Cost Sharing No: ______

Title: "Development of an Automated Trouser Front Pocket Assembly Machine"

ADMINISTRATIVE DATA

OCA Contact John W. Burdette X4820

1) Sponsor Technical Contact:

Lewis Podolske
U.S. Dept. of Commerce
International Trade Administration
Office of Trade Adjustment Assistance
Room 4004, 14th & Constitution, N.W.
Washington, D.C. 20230

2) Sponsor Admin/Contractual Matters:

Rob McNamara (202) 377-5817
U.S. Dept. of Commerce
Office of Federal Assistance
Room 6018
14th & Constitution, N.W.
Washington, D.C. 20230

Defense Priority Rating: N/A

Military Security Classification: N/A
(or) Company/Industrial Proprietary: N/A

RESTRICTIONS

See Attached EDA Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT (see OMB A-110)

COMMENTS:

Project Director is to forward the original copy of the monthly report from Automatech that summarizes the In-Kind Contributions to Grants and Contracts Accounting.

NOTE: Five companies will contribute $91,350 in In-Kind Contributions to the program.

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FORM OCA 4:383

EORGIA INSTITUTE OF TECHNOLOGY | OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date March 4, 1986

ject No. E-27-627 | School/Lab Textile Engineering

udes Subproject No.(s) N/A

ect Director(s) Wayne Tincher | GTRC XGIT

nsor U.S. Department of Commerce-Washington,DC 20230

e "Development of an Automated Trouser Front Pocket Assembly Machine"

ctive Completion Date: 1/31/85 (Performance) 4/30/85 (Reports)

t/Contract Closeout Actions Remaining:

NOTE: Sponsor verified that they have receive all required reports. Project Director is asked to send 2 copies of final report to PPC/SSD if you have not already done so.

- [ ] None
- [XX] Final Fiscal Report SF269
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other ____________

nues Project No. ____________ Continued by Project No. ____________

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Quarterly Progress Report Number 1

Quarterly Progress Report

Number 2

January 1, 1984 - March 31, 1984

DEVELOPMENT OF AN AUTOMATED TROUSER FRONT POCKET ASSEMBLY MACHINE

Department of Commerce Cooperative Agreement No. 99-26-07169-30

GEORGIA INSTITUTE OF TECHNOLOGY
School of Textile Engineering
Atlanta, Georgia 30332

April 1984

Progress Report 2

DEVELOPMENT OF AN AUTOMATED TROUSER FRONT POCKET ASSEMBLY MACHINE

Introduction

The majority of the basic design work for the Automated Trouser Front Pocket Assembly Machine has been completed and assembly of the various subsystems or modules is well underway. The single piece selecting systems have been completed for both pockets and facings. Completion of the transfer devices (sewbots) will complete this subsystem. A working model of the registration system has been completed and tested. This unit appears to do an excellent job of registering two pieces for the joining operation. The modified sewing unit utilizing a belt and pin combination for complex sewing paths (consisting of straight lines and arcs of circles) is also completed. The transfer unit to feed the output of the Front Product Assembly Machine to the pocket closure machine is approximately 50% complete.

Progress on the project at the end of the first six moths has been substantial and the goal of a completed machine for display at the Fall Bobbin Show is a realistic goal.

I. Single Ply Separation System

The system for separating both the pocket and the facings from stacks of cut pants has been completed. Two stacks of pockets (one right and one left) have been equipped with "slicker-pickers" to alternately select a right and a left pocket. The selected pieces will be transported by "sewbots" to the entrance table for the sewing machine.

The rotating table for indexing and delivery of facings has been completed. This device will present left and right facings alternately to the "sewbot" for transfer to the registration system.

All components of the cut parts handling system are complete except the transfer "sewbots" and the electrical control system.

II. Registration System

The registration system has been designed under the assumption that a pocket facing can be placed on the registration table with the critical corner for the sewing operation within 2" of the desired location and within an angle of 15° of the sew line. It has been further assumed that registration cycle time must be less than 3 seconds.

The registration table design is shown in Figure 1. The three push-pull bars were positioned so that a qualitative analysis could be made to determine a first-order approximation of optimal bar locations. It soon became readily evident that the bar pilot positions on the movable table should be kept in line, and, as a function of pocket facing size, the spacing between the bars was also established. The dimensions selected are shown in Figure 1.

A series of readings were taken wherein a simulated pocket facing was placed on the lucite table at maximum error positions and the table then positioned to the zero error position on the facing. The bar lengths were measured both linearly and angularly. This technique, in essence, was a mechanical computer approach to solve an extremely complex geometric-trigonometric problem. The results, indicated that the dimensional layout of Figure 1 was adequate to accomplish the registration requirements provided, the initial placement accuracy was adhered to. This investigation also yielded the information to establish the linear range of each of the servo drives.

The next step in the process was the conversion of the table to a servo driven device capable of performing experimentally the registration process. The push bars were replaced with 1/4-20 threaded rods, motors mounted under the table and belted (timing belts) to the driving nuts.

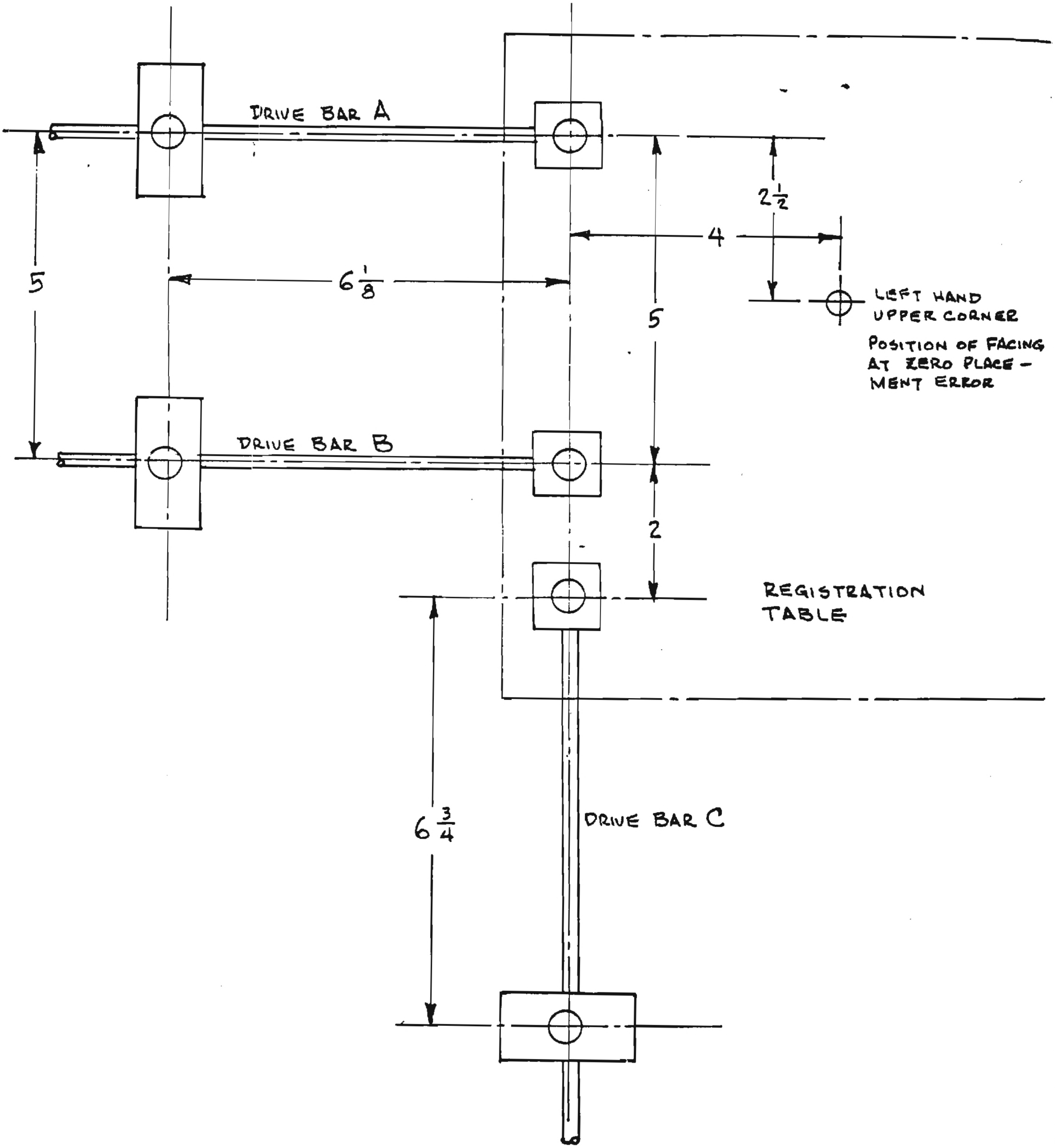
DRIVE BAR A
DRIVE BAR B
DRIVE BAR C
5
6 1/8
4
2 1/2
5
2
6 3/4
LEFT HAND UPPER CORNER
POSITION OF FACING AT ZERO PLACEMENT ERROR
REGISTRATION TABLE

FIGURE 1

The sensors selected were photo transistors (Clairex CLT 2030) placed 3/4" below the fixed table in collimating tubes to minimize reading errors due to possible curl of the material edges. A light source was built to provide light energy to the cells and placed sufficiently high (10") above the tables so as not to interfere with the transfer devices to place and take away the facing.

Sensors were also provided on each servo drive for the return-to-zero position. These are of the GE13A1 type.

A sensor amplifier unit was built. Circuitry was introduced to sense when the servos accomplished their purpose, i.e., final synchronization. When this occurs, the servos are turned off and a signal provided. When registration is complete, a +24 volt pulse of approximately 100 milliseconds is generated. When zeroing is complete, either a like pulse is generated or a constant +24V signal is available.

Because of the experimental nature of this program, many test switches and test points were introduced to readily set up and test each of the 3 drives (A,B & C) independently.

The linear range of each servo is as follows:

	IN	OUT
A	2.5	2.5
B	2.5	2.5
C	2.75	2.5

These limits exceed the requirements as determined earlier and whether or not they should be extended further, must be the subject of additional study.

Because the table as built has many limitations with respect to back-lash and unwanted motions, servo performance must of necessity be limited to prevent oscillations and instability. It is believed that the final table will permit some increase in servo performance, if it is believed to be desired.

An important factor to be faced was the interaction between the 3 servos. The geometry of the devices is such that an angular correction generates both an X and Y error, X correction affects θ and Y, and likewise Y correction affects θ and X. Furthermore, this is not a fixed relationship, but varies with each servo position.

A relay panel was built for system control and, of course, the requisite servo amplifiers were built. The system was turned on and the selection of servo speeds to permit overall system stabilization was not too difficult to accomplish. The voltages supplied to the servos for speed control were: Y=10 volts, X=8 volts and θ=4 volts. The system can accommodate displacement errors of facing lay down much beyond the agreed-upon limits, but it is highly sensitive to initial angular errors beyond the $\pm$ 15°.

The most recent test run (2-11-84) wherein the limits of the error circle was probed yielded the results shown in Table 1.

Table 1

Position	Angle	Register Time	Zero Time	Total Time
1	+15°	1.10	.87	1.97
1	-15°	1.09	.87	1.96
1	0	.96	.64	1.6
2	+15°	1.10	.72	1.82
2	-15°	1.13	.90	2.03
2	0	.80	.54	1.34
3	+15°	1.14	.57	1.71
3	-15°	1.09	.96	2.05
3	0	.72	.64	1.36
4	+15°	1.21	.75	1.96
4	-15°	1.03	.91	1.94
4	0	.77	.57	1.34
5	+15°	1.25	.79	2.04
5	-15°	1.0	.78	1.78
5	0	.96	.58	1.54
6	+15°	1.28	.90	2.18
6	-15°	1.04	.73	1.77
6	0	.82	.50	1.32
7	+15°	1.44	1.07	2.51
7	-15°	1.10	.53	1.63
7	0	.75	.62	1.35
8	+15°	1.14	.90	2.04
8	-15°	1.0	.71	1.71
8	0	.55	.62	1.17

From the data on the preceding page, it is evident that the system response is well within the desired limits. With a tighter system (less slOp) the response can be reduced.

From an operational point of view, it is entirely possible that two potential casualty modes exist. The first is that the transfer fails to pick up a facing and therefore drops no facing on the table. The system has been provided with a sensor which, unless a facing is on the table, the registration mode is inhibited and the operation holds. The second occurs when a facing is picked up and placed on the table, covering the registration inhibit sensor but is far outside the error limits. The system will attempt to correct but it may well be outside the operational range of the table and one of the servos hits its stop and the system is unable to register the piece. A timer (adjustable) has been added and set at 2 1/2 seconds. Should synchronization not occur within this set time. The servos are turned off and an indicator lit, thus protecting the system.

The completed model of the registration table has been delivered to Automatech by Mr. Levine and the version for installation in the machine is being designed.

Although the photocell control system for the registration table is very satisfactory for the current project, other systems for recognizing the position of a part and calculating an error signal for proper registration have been investigated.

Following is a list and description of four different system approaches to the "vision" problem of the registration process.

1. Digital camera
2. Video camera with digitizer
3. Full size photo cell array
4. Several individual photo cells (the method used on the present table)

The digital camera is a camera containing a CCD array onto which the lens focuses the image. This array is a micro-miniature array of photo cells which can be interpreted into values corresponding to the shade of color seen. The information from this array can be accessed by a micro-processor for determining the current orientation of the piece. By comparing this array of information to an "ideal" image stored in an array (in memory), calculations can determine the direction and magnitude of motion necessary to place the piece in its proper orientation for use by an automated machine.

The second system uses a standard video camera to "see" the object. This video signal must then be converted into a digital array capable of being accessed by a micro-processor. This is achieved with a stop frame unit and a digitizer. The digital array in the digitizer may then be interfaced to a micro-processor. This information is then processed in similar fashion as from a digital camera to generate the coordinates for motion necessary to register the piece.

The third system utilizes a photo cell array mounted in a table surface upon which the piece of cloth is placed. The array must be larger than the piece of cloth and the cells mounted in a density that produces suitable resolution. There are two methods of using the information from the array. The first is to use the total array interfaced with a micro-processor in a manner similar to the first two systems using a camera. The second is an analog approach in which only several photo cells are switched on, dependent on pattern and size. The piece of material is driven in certain directions dependant upon the status of these cells. This approach does not require a micro-processor to calculate the direction and magnitude of motion since there is perpetual feedback from the selected photo cells.

The fourth system utilizes several individual photo cells which are physically moved to certain locations previously selected for the specific shape and size of the piece. Constant feedback is required from these photo cells to determine the direction necessary to move the piece and to determine that the piece is finally in its proper orientation.

The first three systems utilize new technology and require significant engineering and design to make them cost effective for this type of machinery. In order to demonstrate the workability of these systems, a working model can be used to prove the principles involved.

Since the information from the digital camera, the video camera with a digitizer, and the full size photo cell array, all enter the microprocessor as a two dimensional data array. This input of information can be simulated by a common digitizing pad. A personal computer can be used to demonstrate the software system for calculating the necessary information to move the piece into proper registration. Once demonstrated, the software can be written for a high speed processor capable of doing the calculations in the desired time frame.

Phase one of the model development is to investigate the methods of inputting the data array into a computer from a digitizer pad in such a format that it is an accurate simulation of data gathered from any of the other digital "vision" systems.

Phase two of the model is the development of software to recognize the location of the piece and calculate the information necessary to move the piece into its proper orientation. At this stage, all output information will be to the CRT screen.

Phase three of the model is to make a working registration table and interface its controls to the computer. At this point a complete registration system will be demonstrated in which a piece of cloth can actually be "seen" by a micro-processor and all necessary information be generated to move that piece of cloth into a predetermined location.

IV. Sewing Station

The transport system for carrying the registered parts to the sewing head has been designed and partially completed. Because of space limitations an under the table transfer device is required to move the parts from the registration area. A very large "feed dog" type device is used for this purpose. A modified "sewbot" will be used to complete the transfer.

The modified automatic pocket sewing machine developed under the previous project is being used for facing attachment. This unit is working quite well.

V. Industry Advisory Committee

The Industry Advisory Committee for the project has been formed and will meet on April 12 at Automatech in Greenville, South Carolina. Members of this committee are:

Mr. James B. Camphill
Thomson Company

Mr. Earl M. Coppagi
Imperial Reading Corporation

Mr. Manuel Gaetan
Bobbin Publication, Inc.

Mr. Kenneth Osburn
Kurt-Salmon Associates

Mr. Jack LeTourneir
Union Special Corporation

The committee will review progress on the project and make recommendations for changes in design and/or construction of the machine.

VI. Budget

A summary of expenditures for the first two quarters is given on the attached sheet.

Financial Report
(Ending March 31, 1984)

CATEGORY	BUDGET	EXPENDED	BALANCE
Georgia Institute of Technology	$ 21,237.00	$ 1,660.58	$ 19,576.42
Subcontract Automatech Industries	174,840.00	96,913.00	77,927.00
Total Dept. of Commerce	$196,077.00	$98,573.58	$ 97,503.42
Cash Contribution (Automatech Industries)	26,350.00	17,454.86	8,895.14
In-kind contribution- Industry Participants	65,000.00	18,020.14	46,979.86
Total Industry Contribution	$ 91,350.00	$ 35,475.00	$ 55,875.00
PROJECT TOTAL	$287,427.00	$134,048.58	$153,378.42

Quarterly Progress Report

Number 3

April 1, 1984 - June 30, 1984

DEVELOPMENT OF AN AUTOMATED TROUSER FRONT POCKET ASSEMBLY MACHINE

Department of Commerce Cooperative Agreement No. 99-26-07169-30

GEORGIA INSTITUTE OF TECHNOLOGY
School of Textile Engineering
Atlanta, Georgia 30332
July 1984

I. INTRODUCTION

Substantial progress has been made this quarter toward completion of the prototype pocket assembly machine. The project is still on target for a completion date prior to the Bobbin Show in September. The first meeting of the industry advisory committee was held in April with a very favorable response to the design concepts used for the machine.

II. STATUS OF PROTOTYPE ASSEMBLY

The five main modules (pocket feeder, facing feeder, combiner, registration table, sewing station) were completed this quarter and all modules have been put through preliminary tests. No major problems have been discovered during testing that will necessitate design changes.

The first transfer unit ("sewbot") used to move parts between the main modules has been tested and some slight alterations are being made. Parts for the remaining 4 sewbots have been purchased and are ready for assembly.

The overall unit control circuit logic and wiring is approximately 90% complete.

Final testing of the completed prototype pocket assembly machine is now planned during late August or early September. In-plant testing will be conducted at the Imperial Reading plant on jeans pockets. Imperial Reading will supply facings, pockets and other assistance for the planned Bobbin Show exhibition.

III. INDUSTRY ADVISORY COMMITTEE

The Industry Advisory Committee hold its first meeting on April 12, 1984, at Automatech Industries in Greenville, South Carolina. Members of the committee present were Mr. James B. Campbell (Thomason Company) Mr. Manuel Gaetan (Bobbin Publication) Mr. Kenneth Osborn (Kurt-Salmon Associates) and

Mr. Jack Le Tournia (Union Special Corp.). Mr. Earl Coppage (Imperial Reading) was unable to attend.

Wayne Tincher (Georgia Tech) opened the meeting with a short presentation on the history of the project and the current objectives of the research program. Mr. Louis Podolske (T.A.A., D.O.C.) described Department of Commerce involvement in the project and the purpose and function of the Industry Advisory Committee.

The major portion of the meeting was devoted to a presentation by Mr. Herman Rovin (Automatech) and Mr. Larry Levine (Consultant) on the design concept and the current progress in development of the various components of the pocket assembly machine.

The meeting concluded with a general discussion of the machine by the Committee. One important suggestion from the Committee was that critical quality control points should be identified for each type of pocket and these critical points should be used, if possible, for control of the placement of parts in registration and sewing.

Mr. Osborn agreed to calculate the return on investment for the machine using the Kurt-Salmon computer program as soon as good cost figures are available.

Comments following and subsequent to the meeting from the committee have been very favorable on both the design approach and progress on the project.

IV. MISCELLANEOUS

A news release has been prepared for apparel industry trade publications. This release has been sent to DOC and Automatech for review and comment.

Considerable interest in the project development has been expressed by Levi-Straus Company. A number of Levi executives have visited Automatech to view the machine and to discuss its application in Levi manufacturing processes. This is further evidence of industry interest in the pocket machine project.

Plans are still underway for a major display of the machine at the September Bobbin Show. A high visibility location has been provided by Bobbin for the showing and Imperial Reading has agreed to participate by providing assistance at the show.

V. FUTURE PLANS

It is anticipated that the design and assembly phase of the project will be completed by the end of the next quarter. This will allow ample time for evaluation and preparation of the final report prior to the project termination date.

VI. BUDGET

A summary of expenditures for the first three quarters is given in the attached sheet.

Financial Report
(Ending June 30, 1984)

CATEGORY	BUDGET	EXPENDED	BALANCE
Georgia Institute of Technology	$ 21,237.00	$ 7,959.58	$ 13,277.42
Subcontract Automatech Industries	174,840.00	145,228.00	29,612.00
Total Dept. of Commerce	$196,077.00	$153,187.58	$42,889.42
Cash Contribution (Automatech Industries)	26,350.00	25,252.23	1,097.77
In-kind contribution- Industry Participants	65,000.00	20,936.43	44,063.57
Total Industry Contribution	$ 91,350.00	$46,188.66	$45,161.34
PROJECT TOTAL	$287,427.00	$199,376.24	$88,050.76

Quarterly Progress Report

Number 4

July 1, 1984 - September 30, 1984

DEVELOPMENT OF AN AUTOMATED TROUSER FRONT POCKET ASSEMBLY MACHINE

Department of Commerce Cooperative Agreement No. 99-26-07169-30

GEORGIA INSTITUTE OF TECHNOLOGY
School of Textile Engineering
Atlanta, Georgia 30332

October 1984

Progress Report

DEVELOPMENT OF AN AUTOMATED TROUSER FRONT POCKET ASSEMBLY MACHINE

I. INTRODUCTION

The prototype automated pocket assembly machine was completed this quarter and displayed at the Bobbin Show on September 18. Initial response to the machine has been very favorable.

II. STATUS OF PROTOTYPE MACHINE

All five main modules of the prototype automated pocket assembly machine were completed and the assembled unit ready for display at the Bobbin Show. As detailed below, the show elicited significant media exposure and considerable interest in the apparel industry.

The machine has been reassembled at the Automatech facility in Greenville and some adjustments and component replacement is underway in preparation for the final field trials.

III. BOBBIN SHOW RESPONSE

A news release prepared by Georgia Tech (see attached copy) and media coverage of the Bobbin Show has resulted in significant publicity for the automated pocket assembly machine project. A partial list of periodicals carrying articles on the machine is given below:

Dunham Morning Herald

Inside R & D

Gwinnett Daily News

The Atlanta Constitution

The Atlanta Journal

The Georgia Tech Whistle

Greenville News

Piedmont Times

Greensboro Daily News

The Charlotte Observer

Thomaston Times

Franklin News & Banner

Atlanta Business Chronicle

Cairo Messenger

In addition, Atlanta TV channels 5 and 11 carried news reports on the machine, and the AP wire service made a report available to subscribers. The Wall Street Journal also plans to carry an article on this development.

One leading expert in the apparel industry was interviewed by the press and summarized the development, "They are at the leading edge, no question about it. It's an important innovation because it can perform many types of sewing operations."

The articles also reported that Levi Straus Company has placed a tentative order for 36 machines.

IV. FUTURE PLANS

The automated pocket assembly machine will be field tested late in 1984 or early 1985.

The final Industrial Advisory Committee meeting will be held at the Automatech facility in Greenville, South Carolina, at 10 A.M. on October 25.

V. BUDGET

A summary of expenditures for the first four quarters is given on the attached sheet.

Financial Report
(Ending September 30, 1984)

CATEGORY	BUDGET	EXPENDED	BALANCE
Georgia Institute of Technology	$ 21,237.00	$ 7,959.58	$ 13,277.42
Subcontract Automatech Industries	174,840.00	169,457.00	5,383.00
Total Dept. of Commerce	$196,077.00	$177,416.58	$ 18,660.42
Cash Contribution (Automatech Industries)	26,350.00	31,599.88	5,247.88
In-kind contribution- Industry Participants	65,000.00	44,476.43	20,523.57
Total Industry Contribution	$ 91,350.00	$ 76,074.31	$ 15,275.69
PROJECT TOTAL	$287,427.00	$253,490.89	$ 33,936.11

TECH HELPING TO DEVELOP
AUTOMATED APPAREL MACHINE

ATLANTA, GA -- Imports have hit the U.S. apparel industry hard in the last few years, but American companies soon may have a way to fight back.

Georgia Tech has worked with a Greenville, S.C., manufacturer to build a machine which automatically sews pockets for trousers.

It is the first time the human operator has been removed from this highly labor intensive process. Textile researchers at Georgia Tech believe the same basic design can lead to a multi-purpose automated apparel machine.

"The long term survival of the American apparel industry probably depends on automation," said Dr. Wayne Tincher, a Georgia Tech Textile Engineering professor. "Importers sold around $8 billion of apparel goods in this country in 1982. That's around 30 percent of the market."

The International Trade Administration of the U.S. Department of Commerce has been so concerned about increased imports that the agency helped fund a research effort by Georgia Tech to develop hardware which reduces production costs for American apparel manufacturers. A team headed by Tincher selected Automatech Industries of Greenville, S.C., to design and build prototype equipment. Tech's School of Textile Engineering has managed the program.

In the first phase of the research project, Automatech built a machine which partially automates the pocket assembly process, leaving the human operator only the task of aligning pieces of fabric to be sewn together. Phase two, which was recently completed, automates even the registration of the cloth.

"This was not a small accomplishment," Tincher said. "Apparel manufacturers work with very tight tolerances. If a seam is even a quarter inch out of register, then the trousers are seconds. The job was complicated by the fact that trouser pocket seaming varies from style to style, and we had to account for these differences." Tincher added that it's more difficult for an automated machine to handle soft, limp materials than a hard clearly defined object. Pieces of fabric often stick together, and one of the principal problems facing Automatech was to make equipment capable of separating one piece of cloth from another in a stack.

"In this regard, our program has been a significant advance," Tincher said. "Mr. Herman Rovin of Automatech designed a device which picks up several fabrics at a time then flips them onto a grated metal surface. This mesh bed catches the top swatch of cloth and holds it as the wheel turns in reverse, returning the unwanted pieces of fabric to the stack.

The machine will be unveiled to the apparel industry at the national Bobbin Show in Atlanta this September. The next phase of the project will be to place one of the machines in an industrial plant setting and make extensive production evaluations.

Later, an effort will begin to apply the basic design for the pocket sewing machine to other apparel assembly processes. For this machine to handle a variety of different sewing tasks automatically, greater computer intelligence will be necessary.

"We'll be investigating a low cost vision system to be interfaced with a dedicated computer," said Tincher. It'll look at fabrics to be sewn together, determine the position for the seam and calculate the correction necessary for the machine to remain in registration."

It is likely, he added, that Georgia Tech and Automatech will collaborate in developing this multi-purpose apparel work station.

######

Development of an Automated

Trouser Front Pocket Assembly Machine

prepared by

School of Textile Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332

July, 1986

DOC Grant NO. 99-26-07169-30
U.S. Department of Commerce
Washington, D.C. 20230

"This technical assistance project was accomplished under a grant from the Department of Commerce. The statements, findings, conclusions, recommendations, and other data in this report are solely those of the grantee and/or its consultants and do not necessarily reflect the views of the U.S. Department of Commerce."

Development of an Automated

Trouser Front Pocket Assembly Machine

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Executive Summary

This report presents results of work completed as part of a Department of Commerce, Office for Trade Adjustment Assistance contract with the Georgia Institute of Technology. The overall purpose of the project work was to develop and evaluate strategies for improving the competitiveness of the American Apparel Industry in the world market place. The purpose of effort herein reported was to design and develop an automated trouser front pocket assembly machine as a specific demonstration of apparel assembly techniques that may be broadly applicable in automated apparel assembly systems. The objective was to design and build a practical machine at as low cost as possible and with immediate utilization in apparel assembly plants.

A proof of concept model of the automated front pocket assembly machine was designed and constructed by Automatech Industries. The machine inputs bundles of cut pockets and pocket facings (in a rotary stack from a previous assembly operation), attaches the facing to the pocket and stacks the finished subassembly all without operator intervention. In this respect the machine represents a significant advance over operator assisted machines commonly used in apparel production.

Trials of the machine conducted on production of jean pockets have shown several design and hardware changes that should be incorporated in prototype machines for in-plant testing.

The modular design of the machine and the design emphasis on versatility should allow this basic machine to be converted into a multipurpose workstation capable of a wide range of subassembly production operations in apparel manufacturing.

The machine has been reviewed by apparel industry experts and was demonstrated at the 1984 Bobbin Show International Exhibit for the Sewn Products Industry. Comments have been very favorable and considerable interest in production models has been expressed.

Table of Contents

I. Introduction

In the past several years, intense interest has focused on the plight of the U.S. fiber-textile-apparel industrial complex resulting from imports of apparel from developing countries. This unfavorable trade balance has already resulted in significant job loss and numerous plant closings in the textile industry.

A major contributor to this difficulty of the U.S. fiber-textile-apparel industrial complex to compete with developing nations is the labor intensive nature of cutting and assembly processes for apparel. The wage structure in developing countries permits apparel assembly in these countries to be conducted at much lower cost due to the labor requirements for these processes. This competitive advantage incourages the development of textile and fiber industries in developing countries to support apparel production.

It is well recognized that automated apparel assembly systems are essential to the long-term growth and survival of the apparel industry in the United States. The importance of this area has been documented in a number of recent conferences and analyses of the apparel industry (1-4).

The current project is an outgrowth of a long term interest in automated apparel assembly by the School of Textile Engineering at Georgia Institute of Technology. Initial work was conducted under a National Science Foundation Project (NSF Grant Number APR:74-02326 "Advanced Technology Applications in Garment Processing") (5).

Work on automated, apparel assembly continued under a DOC Grant (Number 99-26-09857-10, "Opportunities for Productivity Improvement at the Textile-Apparel Interface") (6).

One project on this previous DOC Grant led to development of several innovative concepts in automated apparel assembly (7). The current project was undertaken to further develop these ideas and to conduct, test and evaluate equipment based on these concepts.

II. Project Objectives

The objective of the research project was to develop a prototype completely automated front pocket assembly machine. the machine would receive as inputs stacks of cut parts - facings and pocket linings - and would output stacked pockets with facings attached. Operator attention would be required only to place cut bundles in the feed system, initialize machine settings, and remove stacked bundles from the machine. All single-ply selection, orientation, registration, joining and stacking would be done automatically by the machine. No similar automated apparel assembly machine is known to exist at this time.

The automated machine would use as its basic joining system, the workstation developed as part of the previous contract. This workstation takes as inputs two registered and oriented parts and sews them together in a complex stitching pattern (combinations of straight and curved sewing paths). Additional units to be developed under the research project to convert the workstation into an automated pocket assembly machine included:

1. A single cut piece feeding system.
2. A pattern recognition and orientation system to align parts with respect to the sewing path.
3. An automated combining system to orient two parts with respect to each other prior to sewing.
4. A stacking unit to receive the output of the sewing station and prepare the sewn parts for the next assembly operation.

Although the primary objective of the project was to develop a machine for automated pocket assembly, it was recognized that the ultimate objective was the development of a multi-purpose assembly machine that could be constructed at reasonable cost and which could be immediately applicable in apparel manufacturing. The initial design concept and an important objective in the development of each unit was to produce a machine which could easily be converted to a multi-purpose apparel assembly system.

III. Project Management

The overall research program was under the direction of Dr. Wayne C. Tincher, Professor in the School of Textile Engineering of the Georgia Institute of Technology. The Institute selected Automatech Industries as a subcontractor to develop the prototype pocket assembly machine. Automatech Industries worked with the Institute on a previous project in automated apparel assembly and many of the basic ideas for the assembly system were conceived and developed by Mr. Herman Rovin of Automatech Industries.

Mr. Lawrence Levine served as a consultant on the project and was the major contributor to development of a major component of the system.

The program director received able assistance from an Industry Advisory Board. Members of the Board were:

Dr. Manuel Gaetan
President
Management Services Group
Bobbin International, Inc.

Mr. Kenneth R. Osbourne
Senior Vice President
Kurt-Salmon Associates, Inc.

Mr. Gary Hughes
Engineer
Tomson Company

Mr. Jack LeTourneur
General Manager
Automated Systems-Marketing
Union Special Corporation

Mr. Earl Coppage
Vice President Manufacturing
Imperial Reading Corporation

The board met on a regular basis during the course of the project and provided excellent suggestions and overall direction for the project.

The project was made possible through funding by the Office of Trade Adjustment of the Department of Commerce. Mr. Lewis Podolske of the Office of Trade Adjustment served as contract monitor for the project. Mr. Podolske active participation in the project and his advice and counsel were extremely valuable in leading the project to a successful conclusion.

IV. Background

Apparel manufacturing involves three basic types of production processes--pattern analysis and cutting of parts; garment assembly (usually by sewing) of cut parts into three dimensional shapes; shaping and finishing. In large apparel firms the first of these processes, pattern analysis and part cutting is already highly automated with computer assisted pattern packing (to maxamize fabric utilization) and computer controlled cutting. The garment assembly processes are still largely carried out by individual operators joining parts at a sewing workstation. This area of apparel manufacturing is therefore very labor intensive and in many operations requires highly skilled personnel.

Numerous attempts have been made to increase the automation of these assembly tasks. Most of those attempts have taken the form of simple attachments on the sewing machine to assist the operator in a particular sewing operation. Such devices include folders, needle positioners, thread cutters, completed part stackers etc. More recently, the development of programmable sewing machines has further increased the output of workers by reducing the operator time required for specific sewing tasks.

On a few very large volume processes, single-purpose automated workstations have been developed. These machines may produce shirt collars or cuffs, sew pockets on shirts or blouses, set the back pocket in pants, etc. These devices are a prominent part of manufacturers' displays each year at the Bobbin Show, the annual exhibition for the sewn products industry.

The vast majority of the work in automating apparel assembly has been directed toward operator assisted equipment, i.e. enabling an operator to produce more in a shorter period of time. This equipment is justified by direct comparison of the output per unit time per operator for the operator assisted workstation verses the conventional sewing operation. In many cases manufacturers cannot justify purchase of the operator assisted equipment on this basis. This is especially true for highly complex equipment which is capable of performing only a single assembly operation.

The current research effort differs from these previous approaches in two major respects. First, the apparel assembly workstation was conceived and designed to be an operatorless assembly station. As noted earlier the workstation would accept as input stacks of cut parts and would output finished subassemblies. The separating of parts from stacks, registration of parts, combining, sewing and stacking of finished subassemblies would be accomplished under computer control.

Second, the workstation would be truly multipurpose not single purpose. The workstation should be capable of carrying out many different kinds of assembly operations by changing computer software and with little or no mechanical modifications required to go from one type of assembly operation to another.

The ability of the workstations, not just to assist, but to replace workers and the capability for performing a number of assembly tasks with a single unit should be significant advantages in justifying economically the automation of apparel assembly.

Analysis of typical apparel assembly plants suggests that two basic types of functions are carried out. In the first 50% of a plant, workers take cut parts from stacks and either sew individual parts (example serging) or combine two or more parts together into a subassembly (examples facings on pockets, shirt cuffs, shirt collars). In the last 50% of the plant the subassemblies are combined into three dimensional shapes. These latter operations are very complex and automation of these three dimensional sewing operations will require a significant change in apparel joining technology. It is quite probable that the sewing machine will have to be redesigned before significant automation of these operations will be possible. Such machine design was beyond the time and financial constraints of the current project.

However, two dimensional sewing or the manufacture of subassemblies appeared to be readily adaptable to automated processes. It seemed reasonable that properly designed multipurpose workstations under computer control could perform the vast majority of these operations without operator assistance. Thus, at least half of typical apparel assembly should be amenable to automation within the context of current state-of-the art computer and robotic systems. It was to this area of apparel assembly that the current project was directed.

During 1982 and 1983, the School of Textile Engineering of the Georgia Institute of Technology conducted research under sponsorship of the Economic Development Administration of the Department of commerce on "Automation of Trouser Front Pocket Assembly". This area of apparel assembly was selected for study based on the large volume of pants produced by the United States apparel industry which requires about 1 billion front pockets annually. Production of these pockets necessitates a labor force between 3 and 4 thousand operators.

The principal objective of the research program was the development of a prototype work station for automated assembly of trouser front pockets. The work station as originally conceived was fed manually by an operator with one operator for 2 machines thus reducing the labor content of pocket assembly.

Two important accomplishments resulted from this research. First, an operator assisted pocket assembly work station was developed and tested in an apparel production facility. Based on the design and test results, a production version of the workstation is under construction and several orders for these machines have already been placed. The prototype station generated considerable interest in the apparel industry and was featured in an article in the August, 1983, issue of Bobbin.

The second development resulting from the previous research effort was a single ply separation device. This device is capable of selecting a single piece of fabric from a stack of cut parts for a wide range of fabric weights, weaves, texture and orientations within a bundle (see Appendix A). This development is important in all areas of automated apparel assembly where single parts must be separated from a bundle. The single ply separation device was exhibited at the Bobbin Show in Atlanta, Georgia in 1982. Several apparel equipment manufacturers expressed interest in the single ply separation device as a component in apparel assembly work stations.

With advances made in the previous research project and the experience gained in automated apparel assembly, it appeared possible to completely automate the pocket assembly process. Development of the additional elements required to convert the present pocket assembly machine into a completely automated system was the objective of this research project.

Although this project had as its objective the development of a special purpose workstation for trouser pocket subassembly, the concepts in the design and the hardware development under the project had as the ultimate goal a multipurpose workstation. The machine thus produced with a minimum of modification and addition of overall computer control should be readily converted into a machine that can produce a variety of subassemblies.

V. Conceptual Design

In a typical apparel subassembly operation, an operator selects one part from a bundle of cut parts or from a stack of parts that has already been through a previous operation, selects a second part, combines the two pieces in proper registration with each other, orients the combined parts with respect to the sewing needle, joins the parts in a simple or complex path by sewing or other means, and finally stacks the parts in a manner suitable for the following operation. A model for a work station to simulate these steps in apparel subassembly is shown in Figure 1. The selection devices must be able to accept as inputs either bundles of cut parts from the cutting room or stacked parts from the stacking unit of a previous operation. Registration requires that the geometrical orientation of a part be determined and the part moved to conform with the desired orientation. The combining unit must be capable of accepting the oriented parts, holding them in proper registration with each other and with the joining head. The joining unit must be capable of sewing, fusing, bonding or otherwise joining the parts in a variety of complex paths. The parts must then be removed from the joining unit and stacked in a manner that is compatible with the selection units of subsequent operations.

In addition to the steps shown in Figure 1, some means must be provided to transfer pieces from one unit to the next. This transfer must be accomplished without loss of registration, requires precise translation of pieces in the transfer operation, and in some cases may require rotation of the parts through a specific angle.

In a truly automated work station all of the functions described above must be conducted without human intervention except for initial set-up of the equipment for a given assembly process, supplying stations with stacks of parts and removing stacks of finished subassemblies.

For some subassembly operations, modification of the basic unit would be required. For example, many early steps in apparel assembly require moving only a single part through the sewing station. In this case the second selecting and registering modules in Figure 1 would not be required. In a few cases three parts will need to be combined and joined together. A third selecting and registration unit could be added to the top of the combining unit in Figure 1 to accommodate these situations.

A truly multipurpose workstation requires that the equipment must be capable of handling limp materials to produce subassemblies in a large number of sizes and styles and incorporating a broad range of materials in different types of garments. Changes in any of these characteristics should require a minimum of adjustments and, if possible, should be achieved by software

CONCEPTUAL MODEL

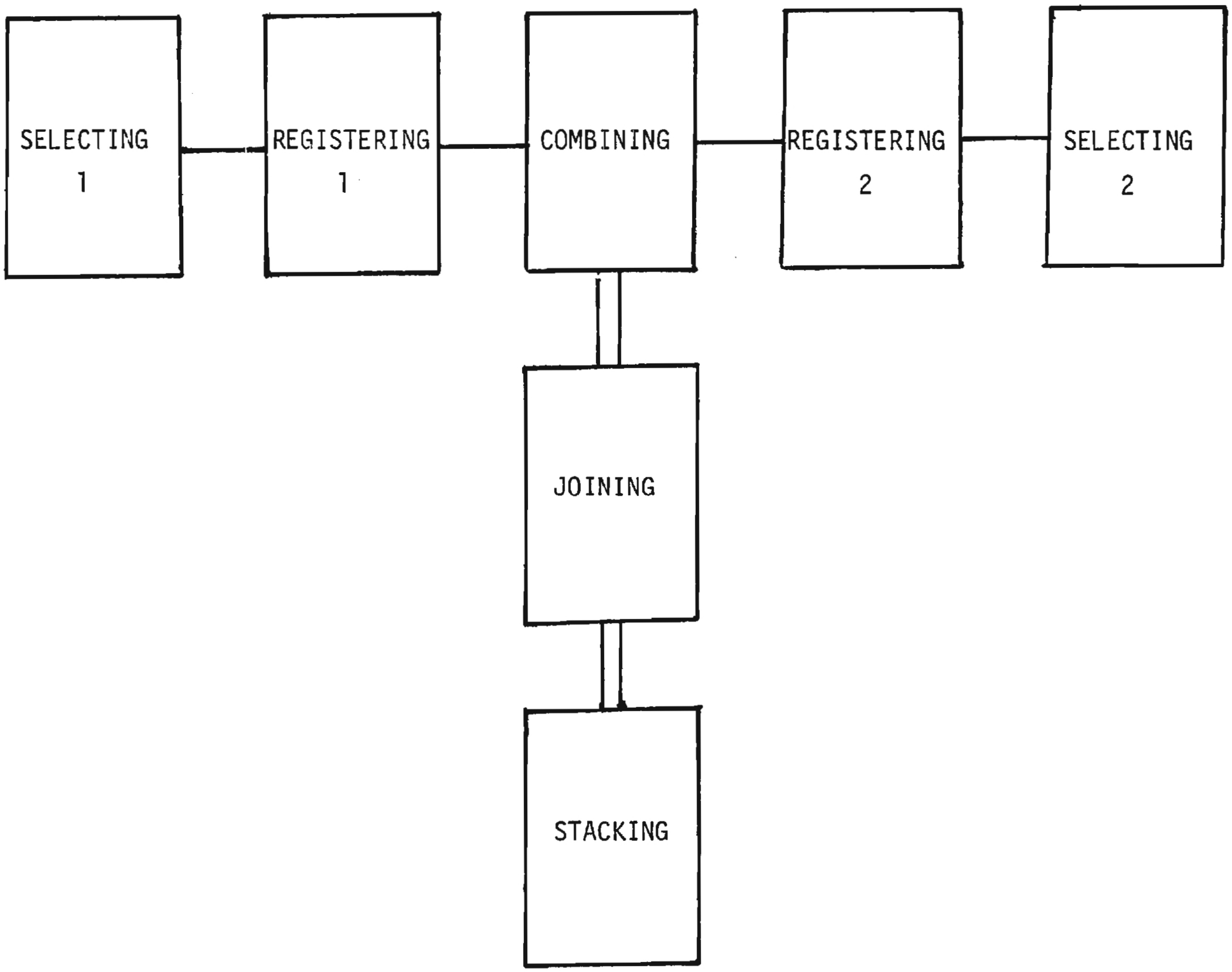

FIGURE 1

changes in the computer control system only. This flexibility must be accomplished in a cost framework compatible with economic realities of the apparel industry.

In achieving these flexibility and economic requirements, it was decided that a modular approach was essential. That is, each of the units shown in Figure 1 and the transfer units to move material between units would be self contained modules containing its own programmable controller. Each unit requires a start signal from the overall computer control unit to begin its cycle of operation and sends a stop signal to the control unit when it has completed it operations. The computer control unit handles sequencing of operations and the timing cycle for the subassembly process. The control computer should also supply to each unit during initialization for a given subassembly production process the data the unit needs to perform its specific operation on the subassemblies for different sizes, styles, and garments.

A second important feature of modular design is that specific workstations could be arranged by selecting the appropriate modular units. Designing units so that the modules may be assembled or bolted together should permit workstations to be assembled for sewing on single parts or for combining three parts by simple rearrangements of the basic modules. It may be necessary to produce modules in small and large sizes to handle the wide range of part sizes (belt loops to pant legs) encountered in apparel production, but the same basic type of modules should be applicable. This concept would appear to offer significant advantages in reducing the cost of automating the apparel subassembly manufacturing steps in both initial capital cost and in stockpiking of spare and replacement parts.

Another important consideration in the design was that, in as far as possible, off-the-shelf items would be used in the design and construction of the workstation. Limitations on project funds would not permit design and construction of all of the components for the system. Therefore, maximum use was made of components that could be purchased and utilized in the workstation. Use of off-the shelf items should also greatly facilitate subsequent manufacture of work stations in a timely manner and at an acceptable price.

VI. Hardware Design

The complete design and construction of a multipurpose workstation was beyond the financial and time constraints of the current project. It was decided therefore to select a specific subassembly and to design a unit for automated production of that subassembly with incorporation of the widest possible flexibility. The design of the unit would be such that it could become a multipurpose workstation with a minimum of modification and addition of external components.

The subassembly selected for the automated workstation was the assembly of trouser front pockets. These subassemblies are made in large volume in apparel manufacturing and would therefore offer an excellent opportunity for testing the design and hardware concepts. This unit would also make maximum use of the work completed in the previous research (7).

The front pocket subassembly workstation is shown in Figure 2. The basic function of this unit is to sew facings onto a front trouser pocket. The pocket linings are brought to the automated hardware in the form of cut stacks from the cutting room. The facings were also originally cut in multiple layer stacks but had to undergo a previous operation before coming to this work group. For that reason it was decided that there should be two types of cloth feeder units; one to accept multi-ply cut stacks and one to accept material that has undergone a previous operation. In line with this, it was also reasoned that only stacks from the cutting room needed to be picked (or separated) one ply at a time. If an input stack were to come from a previous operation, then it should be re-stacked so that separation was not required again. Only one registration unit was constructed since it was felt that a bundle of cut pockets could be maintained in a fixed orientation so that registration would not be required. This assumption later proved to be in error.

The basic operation of the unit is as follows:

1). A pocket lining is separated from a stack of linings and transferred by the "Sewbot" to the combining unit.

2). A pocket facing is selected from the rotary feeder and transferred by a second "Sewbot" to the registration unit. It is oriented and then transferred to the combining unit by "Sewbot" 3.

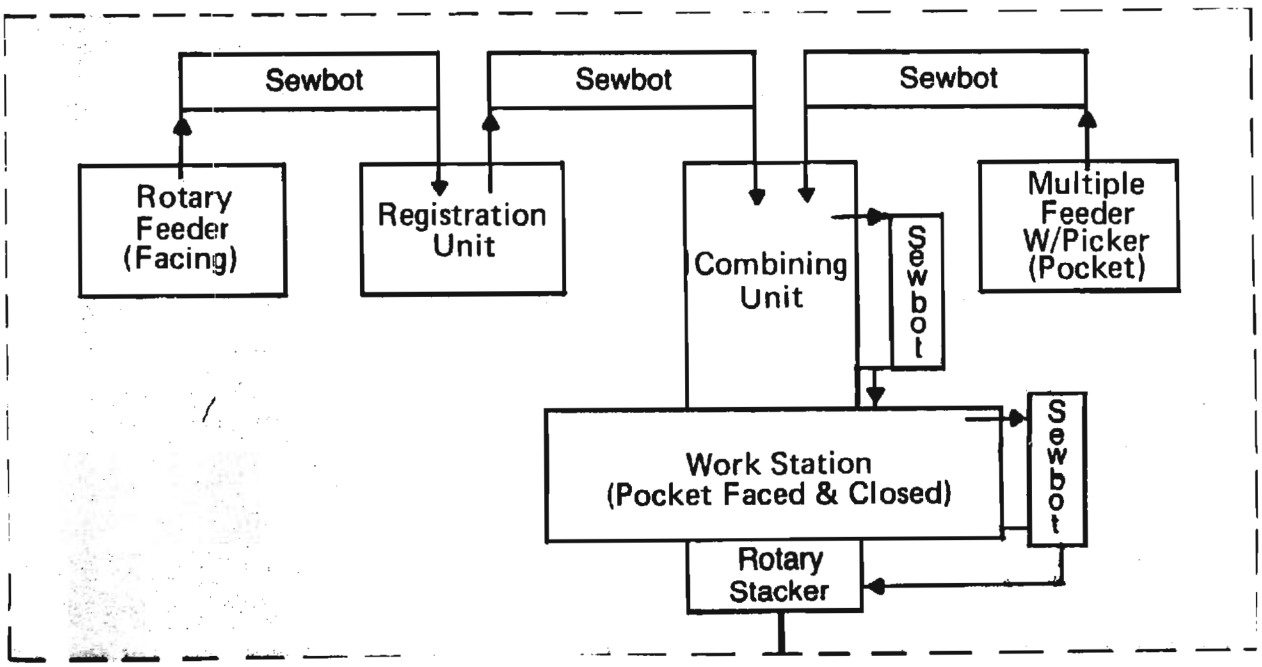

FIGURE 2

FRONT POCKET ASSEMBLY WORKSTATION

3). The pocket with registered facing is then transferred to the joining station by "Sewbot" 4 and the facing is sewed to the lining by a programmable sewing unit.

4). The pocket with attached facing is then transferred by "Sewbot" 5 to a rotary stacking unit.

The functioning of each of these separate units will now be detailed.

A. Bundle Feeder (Multiple Feeder with Picker)

This feeder was designed to accept multi-plied stacks of pocket linings from the cutting room. The multi-feeder accepted two such stacks, one placed for a right pocket and one for a left pocket. The feeder shifted after each cycle so as to present a right and left pocket alternately. This was also done to keep all pieces in pairs. The use of more than one pile of pockets allowed for a greater quantity of incoming goods so that operator attendance was not as frequent. The multi-feeder contained a single ply separation device for each stack of pockets. Two stacks therefore aided in shortening the time cycle. The multi-feeder has the capability of elevating the input stack as it is used up. The multi-feeder is mechanically free standing and contains its own power supply and electrical control subsystem. The multi-feeder can be operated independently from the fully automated system by switching it to a "Local" mode. The three basic functions of picking, shifting, or elevating can be separately controlled from its local control panel.

The single ply separation device ("slicker-picker") was developed as part of the previous research project (7). It has the capability of selecting a single ply of fabric from a bundle of cut parts for a wide range of fabric types, fabric weights, and fabric textures. A detailed description of the operation of the single ply separation device is given in Appendix A.

B. Rotary Feeder and Rotary Stacker

The rotary feeder was designed to handle stacks of parts that have been through a previous operation between the cutting room and this particular operation. In the case of the pocket facings the original stack from the cutting room had to go through an operation where each right pocket facing had a "watch" or "coin" pocket attached to it. The original stack had to be separated in order to undergo that operation. It was at that operation that the facings were placed on a "rotary stacker". Each time a finished facing was placed on the rotary stack, the stacker indexed 30 degrees. By so doing, each individual facing was kept separated from the previous one. It no longer would require a "slicker-picker" to separate it from the previous one. Furthermore, by stacking each piece offset from the previous piece, the local protuberances (such as hems etc.) did not pile on top of each other so as to form an unstable stack. Indeed, it is possible with a rotary stack to pile a considerable number of small pieces on top of each other. The <u>absolute location</u> of each piece in this rotary stack is not known, but within some acceptable tolerance limit its orientation is known. A rotary feeder accepts this stack of facings, and after each piece is removed, the feeder indexes the same 30 degrees as the stacker. If the stacker rotated in a clockwise direction, then the feeder rotates in a counter-clockwise direction. Both the rotary feeder and rotary stacker have the capability to raise or lower the stack as it is being used up or stacked up respectively. Like the multi-feeder, they each contain their own power supply and local controls and each of these units is also free standing.

C. Registration Unit

As previously explained with the rotary feeder/stacker, the accurate position of each facing is not known. It is necessary, therefore, to take each facing from the rotary feeder and orient or register it so that it is in proper orientation to both the pocket lining and to the direction to start sewing. The function of the registration station is to accomplish the exact registration. If a facing is placed out of register by $\pm$ 2 inches in the "X" and "Y" axes or $\pm$ 20 degrees in rotation, the registration unit will re-orient the piece to proper predetermined photo-cell locations. These photocell locations are readily adjustable to accommodate various sizes and shapes (as well as types of cloth) from which facings are made. The time to accomplish the orientation from the above listed displacements is approximately 3/4 of a second. Like the feeders or stacker, the registration unit contains its own power supply and controls. It can be operated locally as a separate unit or automatically in conjunction with a series of units set into a complete work group. It too is a mechanically free standing unit. A detailed description of the registration unit is given in Appendix B.

D. Combining Unit

The combining unit was designed simply as a device which can accept two pieces of registered cloth, placed one on top of the other, and can move those two pieces without disturbing their position. The movement of these pieces had to be done from below, since there were too many elements coming in from the top. Mechanical interference as well as time cycle determined this arrangement. The combiner consisted of a moving grate with both vertical as well as linear motion. The entire grate moves much in the manner of a sewing machine feed dog. The moving grate is large enough to cover the entire area of a pocket lining. The moving grate moves within a stationary outer grate. The two pieces are placed on top of the stationary grate at which time the moving grate is below the surface of the stationary grate. The moving grate rises between the bars of the stationary grate and lifts both pieces off of the stationary grate. The moving grate has a very high friction surface so that the cloth pieces will not slip with respect to the moving grate. After lifting, the moving grate slides to a new position further towards the work station. the moving grate then lowers and re-deposits the combined pieces onto a new section of the stationary grate. The moving grate then returns to pick up the next set of combined pieces. This unit is again free standing and contains its own local controls as do all the other units in the grouping.

E. Joining Unit

This unit contains all the elements necessary for joining the two pieces of cloth. In this case, it contains a sewing head, a belt drive, a pivot pin and a take away drive unit. the sewing head does the actual joining while belt and pivot pin are used to steer the cloth through the sewing head. The take away drive is used to assist in removing the sewn assembly. The work station contains its own micro-processor unit because of the necessity to change programs due to style changes. This particular work station also contains the ability to "dial select" changes as a result of size requirements that do not necessitate a program change. The work station is also free standing and can be mounted on casters. This allows the work station to be removed rapidly and replaced with another one. This was not done for servicing as much as it was done for adapting the group of hardware to perform a different function. The work station, as all the other units, has its own power supply and control panel. It can be operated independently from the main group micro-processor control. It requires only a "go" signal from the main processor and will in turn send the main processor a signal upon completion of its function.

The details of the programmed sewing in the joining unit are given in Appendix C.

F. Transfer Units ("Sewbots")

The "Sewbots" are the cloth transport units. They operate between each of the respective units. There are five such sewbots contained within this group. (The stacking Sewbot after the work station and the rotary stacker itself were never actually built. This was due to the shortage of funds). Each of the sewbots have a minimum of two axes. The first sewbot moving between the multi-feeder and the combiner (pocket linings) has three axes of motion. The reason for this was to help accommodate the alternate right-left pocket requirements. The sewbots have a basic "X" motion linear axis. The stroke can be pre-set to an desired distance. The accuracy of positioning is within $\pm$ .010 inches. This axis is D.C. motor driven and can be servocontrolled, or controlled by a manual switch set. As used in this prototype, all the Sewbots were limit switch set since only the end positions were of any importance. All sewbots have a vertical lift and drop motion of 2 inches. This is accomplished by air cylinder action. The main vertical shaft and second axis of motion is the piston of the air cylinder. The piston is hollow to allow the possibility of drawing a vacuum through it. The third axis is rotational about the center of the vertical piston. this axis is D.C. motor driven and can be servo-controlled to stop at any desired angle, or can be limit switch set manually. Its accuracy is also within $\pm$ .010 inches. The sewbots are independently supported and can be set in any position required. They are capable of being operated in local control or as part of an overall automatic system. They too require a "go" signal and will return a "completion" signal when they have accomplished their task. As compared to modern robots, the sewbots are much simpler and all six of them would be a fraction of the cost of a six axis servo-controlled robot.

The main vertical piston shaft is designed to have a variety of end effectors attached to it. The pick up of single pieces is done with vacuum and for such purposes any number of different vacuum boxes or nozzles can be attached. The upper end of the vertical shaft has an air operated vacuum valve mounted to it for turning the vacuum on and off. Different mechanical arms for sliding pieces along tables, or grippers for clamping pieces can be added to the vertical shaft in place of the vacuum arms. The sewbots are designed to be operated from their own local panel, or remotely by any relay or micro-processor unit.

G. Electrical Control System

The main controller for the overall system is a Gould Modicon Micro 84 programmable controller. The main unit has 4 input and 4 output modules. As previously mentioned, all of the other units have their own power sources and their own local control circuitry. Most of these circuits are simple relay switch systems that receive signals to start their function and send out signals when they have completed their function. In this manner there is cross talk information between each of these units and the main controller. The joining unit because of its physical requirements (such as type of sewing head, types of folders or special handling devices, type of steering capability, and types of drive systems both electric or pneumatic) make this part of the work station peculiar to the particular operation to be performed. The joining unit therefore contains its own Gould Modicon Micro 84 programmable controller. It has only 2 input and 2 output modules. The P.C. #2 in the work station must also converse with the main P.C. #1 in the control cabinet. Anytime a joining unit has to be changed, then any other joining unit performing a different function (with its own programmer) can be moved to the location and plugged in.

VII. Evaluation of Concept and Design

The workstation shown schematically in Figure 2 was constructed at Automatech and has been subjected to extensive testing. The completed workstation was demonstrated for the Industry Advisory Group on October 25, 1984 and was introduced to the apparel industry at the Bobbin Show in September of 1984. Assessments of the Industry Advisory Group and press comments on the development of the automated workstation are give in Appendix

D. These assessments are very favorable and indicate that the automated workstation represents a break-through in design of automated apparel assembly systems.

Subsequent to the fall 1984 Bobbin Show, the equipment has been demonstrated for a number of apparel industry executives at the Automatech Industries plant and has generated considerable interest in commercial applications.

Testing of the proof-of-concept model has revealed certain deficiencies that require modification prior to extensive in-plant testing. Some of these deficiencies are hardware failure problems and some will require design changes.

First, the "Sewbot" transfer unit gear boxes proved inadequate for long term use. These gear boxes must be replaced or modified to withstand the rigors of operation on the plant floor.

Second, it has not been possible to maintain registration of the cut stacks of pockets in the design shown in Figure 2. The test runs have shown that as the pockets are separated from the bundles the stack tends to shift. Therefore, a second registration unit should be placed between Feeder Unit and the Combining Unit. This second Registration Unit would, of course, be required for a truly multipurpose workstation.

Third, the time cycle that was the target for this workstation was 4 seconds per cycle. This time cycle was not achieved. An actual time cycle of 11 seconds is typical. One of the major causes of the longer time cycle is the "Slicker Picker" single ply separation device. The best solution to this problem would be to do all picking off-line and feed only rotary stacks of cut parts to the assembly units. This approach would have considerable merit employing units using hardware developed for this project ("Slicker-Picker", one "Sewbot", and Rotary Stacker Unit). Such units should fit in well with current production practices and would simplify the design of the multipurpose automated workstation.

The Combining Unit is too awkward in design and also contributed to the long time cycle. This unit will require redesign in order to achieve the desired time cycle.

The changes suggested above should permit achieving the 4 second time cycle objective initially planned for the automated workstation.

A fourth important improvement which must be made on the current workstation is the installation of detection devices needed to prevent the making of off quality parts. For example, thread break detection, bobbin replacement, and absence of pieces detection are a few of the devices needed to insure quality of production.

VIII. Future Developments

The automated pocket assembly machine will require a number of modifications to become a multipurpose apparel assembly workstation. Such a workstation would accept as inputs parts on a rotary stack similar to the unit used in the pocket machine. These stacks would come from two sources--partially completed subassemblies from previous automated workstations and rotary stacks produced with workstations specifically designed to take bundles of cut parts and prepare rotary stacks. This unit would consist of a "Slicker Picker", "Sewbot", and a rotary stacking unit. Cut parts would then be transferred from the rotary stacks to a registration unit. The registration unit must be able to sense the position of a part and to compare this position with the desired position and move the part to this desired position. The registered parts would then be brought together and sewn (or joined) with the desired stitch path. The subassembly would then be stacked for the next operation.

There are several important criteria for such stations to be truly multipurpose:

1. Changes from on size to another should require no hardware adjustments but should be under software control.

2. Mechanical adjustments for making different subassemblies should be minimized and unnecessary for many changes between subassemblies.

3. In many changeovers the system should be capable of making the necessary changes without operator intervention. For example a bar code on the input rotary stacker could call up the program for a particular subassembly.

To accomplish these objectives each workstation would require a computer for overall system control. This computer would receive information about the subassembly to be produced and would recall from permanent memory (proms or disk) the parameters required for the particular subassembly and would communicate these parameters to each of the units in the workstation. After this initialization the computer would assume the task of registration and overall cycle control for the various units in the workstation. The input and output units--rotary stackers and rotary feeding units--are already capable of interface with the computer as they only require a start signal and respond with a stop signal when the task is completed. Some modification of the other units will be required for multipurpose automated production.

A. "Sewbots"

As currently configured the "Sewbots" are controlled by microswitches. These must be repositioned to change the distance of transfer of parts within the workstation. They are designed to operate with servo control so that the programmable controller in the "Sewbot" must have the capability of downloading from the computer (during initialization for production of a given size subassembly) the integrator values necessary for the servo control system. This would require values for the vertical axis, horizontal axis and degree of rotation in a three axis "Sewbot". Only start and stop signals would be required between the computer and the "Sewbot" during the production cycle.

B. Joining Unit

It is probable that two kinds of joining units will be required for a large percentage of subassembly production. One would be capable of sensing the edge of a cut part and following that edge in the sewing operation. The edge sensor sewing unit would require only the start-stop signal communications with the computer during control of the sewing cycle.

The second type of joining unit would be essentially similar to the unit designed for the automated pocket machine. This unit is a programmed sewing machine using a combination of a pin and a belt to produce any combination of arcs of circles and straight lines in the sewn pattern. The various components in this programmable sewing machine were designed to operate under servo control tied directly to the sewing machine motor. The programmed sewing station would require downloading from the control computer all parameters needed to control the sewing pattern during initialization. These would include parameters for setting the length of straight stitching and the radius and arc length of curved stitching for a given subassembly. The programmed sewing unit could then operate with only the standard start-stop cycle control commands required by all other units in the workstation.

It is also clear that additional attachments for the joining unit will be required for some subassembly operations. The attachment of folders and other similar fabric handling components would be required for certain types of subassemblies. The degree to which these types of assembly can be completely automated has not been investigated during the current project. It should receive additional attention in any continuing research effort.

C. Registration Unit

The registration unit would require intricate interactions with the control computer during the production process. In its current version the registration unit utilizes three photocells to determine when a part is in the proper orientation for combining with a second part in the joining operation. Signals from three photocells control the drive system that move the part until the orientation is correct. The positions of these photocells must be adjusted by hand for different size parts of the same subassembly or for parts of different subassemblies. A truly multipurpose workstation requires that these photocells be replaced with a vision system directly interfaced with the control computer.

The requirements for the vision system are much less demanding than in other robotics systems. It is only necessary to sense and manipulate data describing the edges of the cut piece and, in a simple system, only two levels of brightness in only 2 dimensions. The signal from the vision system can then be compared with the orientation of the part stored in the control computer and the appropriate error signals generated and transmitted to the motors controlling the position of the table on which the part rests. It is probable that the centroid and the initial point of contact with the sewing needle could be calculated and used to generate the error signals required to control the position motors. Information on data generation and manipulation by vision systems is available in a number of recent references (8,9). It appears that there are no major limitations on interfacing the mechanical aspects of the current registration system with a suitable vision system.

The registration unit would be one point at which detection of machine failures would be possible. For example the vision system could determine if a part had been delivered, if the part were folded or miscut, or if the position was outside the range of movement of the registration table.

Although other required modifications would undoubtedly be discovered as the workstation is developed, the items discussed above appear to be the major changes needed to convert the current workstation into a multipurpose automated assembly system.

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APPENDIX A

Appendix A

Design of a Ply Separation Device

Over the past twenty years there have been many attempts at cloth separation by such firms as Pfaff, A.E.L., Jacobs, United Shoe Machinery, Jet-Sew, Gepec and others. Every method of application - sticky tape, precise penetration of pins, vacuum, mechanical rolling, twisting or stretching has been attempted. Only one unit, the "Clu-Picker" by Cluett Peabody (Jet-Sew) has managed to survive. Its reputation on specific types of cloth has been fairly good but it still does not appear to have solved the problems of cloth separation regardless of the nature of the type of cloth involved. The main reason for this appears to be the fact that, like all other previous types of pickers, the unit attempts to pick only one piece from the stack of cut parts.

This concept of picking must rely on the force of attraction (due to friction etc.) between pieces being sufficiently low, that only one piece is removed from the stack. The force of adhesion between pieces in the stack is subject to a number of variables that are beyond the control of the machine designer.

Cloth pieces will stick to each other due to such conditions as:

1. Nap
2. Static electricity
3. Interweaving of strands at the cut edges
4. Actual welding of edges (especially in the case of polyesters that may have been cut with dull knives)
5. Mechanical interlocking such as in the wales of corduroy.

To date, the human hand has been the only device capable of successfully separating any piece, of any type, from any stack of cloth. The human does not, however, attempt to pick up one piece in the first motion. Rather it endeavors to pick up several and then discards those that it does not want. The human then relies on the sensing ability built within its fingers, brain, and nervous system to detect the fact that it has discarded all but one piece. The imitation of the human process is the concept on which the 'slicker-picker' is based. This unit was developed as part of a previous project and utilized in the design of the general purpose workstation.

The picker has a rotating wheel covered with a polyurethane rubber that rotates atop a stack of cut parts. This rotation will lift several piles from the stack. The top ply is held by a small piece of cloth with embedded vertical wires (card-clothing), and the wheel's direction is reversed to return the unwanted pieces to the stack of cut parts. Thus, the 'slicker-picker' does not attempt to separate cut parts for which the uncontrolled force of attraction between two pieces is the determining factor in the separation process. Rather the 'slicker-picker' removes several pieces from the stack, holds the top piece by a piece of card clothing (with a controlled adhesive force), then separates the additional cut parts from this restrained top piece. The separation process, therefore, is determined by the friction of the rotating wheel against the fabric and the restraining force of the card clothing. In the 'slicker-picker'both of these forces can be controlled independently of the nature of the cloth. This makes the 'slicker-picker' distinct from all other types of pickers that have so far been invented or produced. It also makes the probability of success for the 'slicker-picker' greater in its ability to separate a wide variety of weights and types of coth.

The detail designs of both the card clothing and the polyurethane wheel required significasnt levels of mechanical know-how to construct them to function properly. This was mostly attained through trial and error procedures.

Any effects on the separation process due to the height of the stack of cut parts were nullified by having the separator sense when it met the top layer so that no undue strains or pressures were put on the stack. This prevented the "mushiness" or compressibility of a tall stack (as compared to a very short stack) from affecting the action of the separating device. A cloth covered foam rubber bed was used beneath the stack so that the action of the sensing device would still face the same relative compressibility as it approaches the end of a stack as it would with a full stack.

The separator has a self contained clamp which reclamps the entire stack each time a ply has been separated. In this manner the separated ply can be removed by a host of different devices without disturbing the rest of the stack. The lower limit as to size of piece that can be separated is 4 1/4" plus at least one inch more for a transfer device to grab the segmented pieces. The width of the separator is 2 inches. Large pieces of cloth can be separated by placing the picker in a catty-cornered attitude with respect to the stack. On a pant leg, for instance, two separators could be used, one in each corner, either at the cuff end or at the waist end.

Thus the design of the separation system makes possible the following accomplishments:

1. It is capable of separating one ply of cloth (and one ply only) from a stack of cloth.

2. The height of the stack can vary up to 3" (a typical height for stacks of cut parts).

3. It is capable of separating any size or shape from a few inches to 4 feet (a range from fly pieces to pant legs were considered to be the end limits).

4. Any changes to the hardware required to handle various textures or thicknesses of cloth can be made quickly by plant operating personnel in accordance with previously established settings.

5. The softness or "mushiness" of the stack does not affect the ability to separate a single ply.

6. The separator is not required to transfer the individual separated piece, but can work in conjunction with various cloth handling machines and/or robots.

7. The separator is capable of accepting a signal (pulse only) to start its operation.

8. The separator in turn is capable of sending out a signal upon completion of its cycle (switch closure only).

9. The separator when production engineered should be capable of selling at a retail level not to exceed $1,500 to ensure wide acceptance in a variety of assembly operations.

Page A-5 missingfrom report.

All of the design criteria have been met, with only two exceptions:

1. A picker that could separate all types of cloth was the objective. However, cloths such as 'tricot' will not be separated by this device or virtually any other device. The delicacy of the material prohibits most handling because of the possibility of damage to the cloth. Further, it has a natural tendency to roll into a cylindrical shape after having been cut.

2. A time cycle of 2 seconds was desirable for the picker. The actual time cycle varies from 4 seconds to 5.5 seconds depending on the type of cloth. The thickness and stiffness of the cloth affect the ability of the picker to pick up several plies. Therefore, more time is needed to pick. The same is true of the peeling cycle. More time is required to peel off the unwanted plies based on their thickness and stiffness. This will require more than 1 picker on a machine to maintain production rates.

The following fabrics have been tried successfully but testing was not extensive.

1. Denim (6 oz to 14 oz)
2. Corduroy (light wales)
3. Sheeting (polyesters or cotton)
4. Shirting (polyesters or cotton)
4. Shirting (polyesters or cotton)
5. Flannelette
6. Seer Sucker
7. Non-woven
8. Double knit (for pants or skirting)

9. Pocketing Material

10. Some light curtain fabirc

The separator requires only three adjustments to function properly on all types of cloth.

1. The sensing of the top layer of the stack. This will determine how far the picker wheel will penetrate the stack. For very light cloths (thin and limp) the penetration whould be minimal in order not to pick up too many and therefore have to peel off too many pieces. This will also prevent the more delicate fabric from being damaged by continuous pick-up and peel-off. For heavy or stiff cloths (such as denim) the penetration should be maximum.

2. The penetration of the points of the card clothing must also be adjusted for light or heavy cloths. Obviously the penetration can be greater for thick cloths. On lighter cloth, the penetration must be minimal in order to keep from sticking through two pieces. The amount of penetration on the light cloth is not minutely critical since the beating of the peeling wheel during peeling will help to dislodge the second piece which may have been partially penetrated by the card wire.

3. Timing adjustments for both the length of pick time and the length of peel time are required again based on the variations between light and heavy cloths.

All of these adjustments can be made in a matter of seconds and are denoted by dial settings so that they can be recorded and return to at will. Alternatively the card clothing can be mounted on a metal slide which allows easy replacement of the metal teeth for different types of fabrics.

The prototype separator design included the ability to function completely automatically, or in a step-by-step fashion. This system allowed for independent observation of each step in the process. This, of course, was done with the intention of using the prototype as a test bench to determine the ranges of cloth types it could handle, and may not be necessary in production models.

The 'slicker picker' has performed quite well in lab trials, and has created considerable interest among apparel manufacturers. It has great promise as an important component in a wide range of automated apparel assembly system.

APPENDIX B

Appendix B

Design of a Registration System

The registration system has been designed under the assumption that a pocket facing can be placed on the registration table with the critical point for the sewing operation within 2" of the desired location and within an angle of 15 of the sew line. It has been further assumed that registration cycle time must be less than 3 seconds.

The registration table design is shown in Figure B.-1. The three push-pull bars were positioned so that a qualitative analysis could be made to determine a first-order approximation of optimal bar locations. It soon became readily evident that the bar pilot positions on the movable table should be kept in line, and, as a function of pocket facing size, the spacing between the bars was also established. The dimensions selected are shown in Figure B.-1.

A series of readings were taken wherein a simulated pocket facing was placed on the Lucite table at maximum error positions and the table then positioned to the zero error position on the facing. The bar lengths were measured both linearly and angularly. This technique, in essence, was a mechanical computer approach to solve an extremely complex geometric-trigonometric problem. The results, indicated that the dimensional layout of Figure B-1 was adequate to accomplish the registration requirements provided, the initial placement accuracy was adhered to. This investigation also yielded the information to establish the linear range of each of the servo drives.

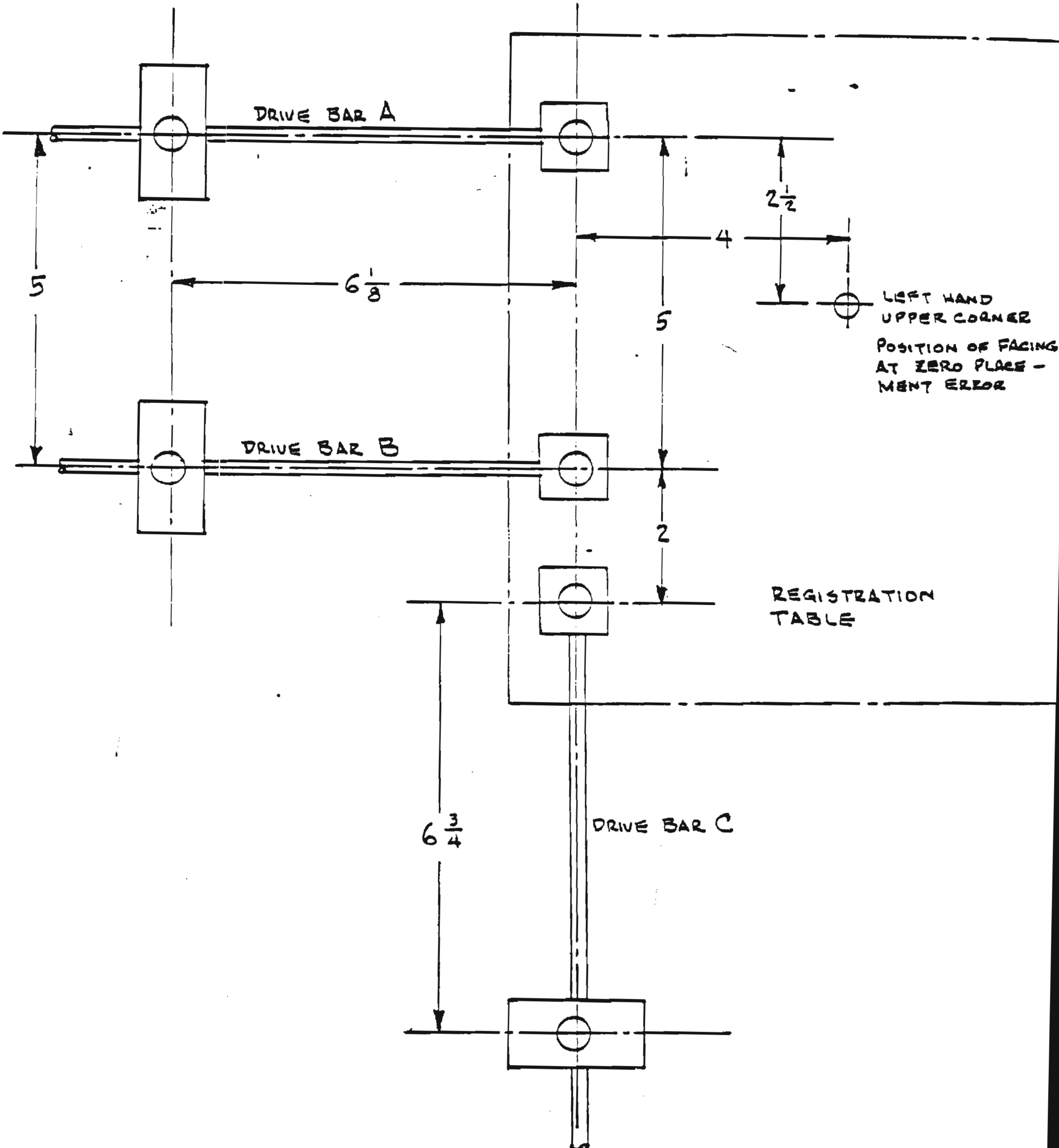

DRIVE BAR A
5
6 1/8
2 1/2
4
5
LEFT HAND UPPER CORNER
POSITION OF FACING AT ZERO PLACEMENT ERROR
DRIVE BAR B
2
REGISTRATION TABLE
6 3/4
DRIVE BAR C

Figure B-1

The next step in the process was the conversion of the table to a servo driven device capable of performing experimentally the registration process. The push bars were replaced with 1/4-20 threaded rods, motors mounted under the table and belted (timing belts) to the driving nuts.

The sensors selected were photo transistors (Clairex CLT 2030) placed 3/4" below the fixed table in collimating tubes to minimize reading errors due to possible curl of the material edges. A light source was built to provide light energy to the cells and placed sufficiently high (10") above the tables so as not to interfere with the transfer devices to place and take away the facing.

Sensors were also provided on each servo drive for the return-to-zero position. These are of the GE13A1 type.

A sensor amplifier unit was built. Circuitry was introduced to sense when the servos accomplished their purpose, i.e., final synchronization. When this occurs, the servos are turned off and a signal provided. When registration is complete, a +24 volt pulse of approximately 100 milliseconds is generated. When zeroing is complete, either a like pulse is generated or a constant +24V signal is available.

Because of the experimental nature of this program, many test switches and test points were introduced to readily set up and test each of the 3 drives (A,B & C) independently.

The linear range of each servo is as follows:

	IN	OUT
A	2.5	2.5
B	2.5	2.5
C	2.75	2.5

These limits exceed the requirements as determined earlier and whether or not they should be extended further, must be the subject of additional study.

A relay panel was built for system control and, of course, the requisite servo amplifiers were built. The system was turned on and the selection of servo speeds to permit overall system stabilization was not too difficult to accomplish. The voltages supplied to the servos for speed control were: Y=1Ø volts, X=8 volts and Ø=4 volts. The system can accommodate displacement errors of facing lay down much beyond the agreed-upon limits, but it is highly sensitive to initial angular errors beyond the ± 15.

A test run (2-11-84) wherein the limits of the error circle were probed, yielded the results shown in Table B.-1.

From the data on the following page, it is evident that the system response is well within the desired limits. With a tighter system (less play) the response time can be reduced.

From an operational point of view, it is entirely possible that two potential casualty modes exist. The first is that the transfer fails to pick up a facing and therefore drops no facing on the table. The system has been provided with a sensor which, unless a facing is on the table, the registration mode is inhibited and the operation holds. The second occurs when a facing is picked up and placed on the table, covering the registration inhibit sensor but is far outside the error limits. The system will attempt to correct but it may well be outside the operational range of the table and one of the servos hits its stop and the system is unable to register the piece. A timer

Table B-1

Position	Angle	Register Time	Zero Time	Total Time
1	+15°	1.10	.87	1.97
1	-15°	1.09	.87	1.96
1	0	.96	.64	1.6
2	+15°	1.10	.72	1.82
2	-15°	1.13	.90	2.03
2	0	.80	.54	1.34
3	+15°	1.14	.57	1.71
3	-15°	1.09	.96	2.05
3	0	.72	.64	1.36
4	+15°	1.21	.75	1.96
4	-15°	1.03	.91	1.94
4	0	.77	.57	1.34
5	+15°	1.25	.79	2.04
5	-15°	1.0	.78	1.78
5	0	.96	.58	1.54
6	+15°	1.28	.90	2.18
6	-15°	1.04	.73	1.77
6	0	.82	.50	1.32
7	+15°	1.44	1.07	2.51
7	-15°	1.10	.53	1.63
7	0	.75	.62	1.35
8	+15°	1.14	.90	2.04
8	-15°	1.0	.71	1.71
8	0	.55	.62	1.17

(adjustable) has been added and set at 2 1/2 seconds. Should synchronization not ocur within this set time. The servos are turned off and an indicator lit, thus protecting the system.

Although the photocell control system for the registration table is very satisfactory for the current project, other systems for recognizing the position of a part and calculating an error signal for proper registration will be essential for a multipurpose work station.

APPENDIX C

Appendix C

Operation of Programmed Sewing Unit

A. Description of the path to be followed and sewn (REF Fig. C-1).

B. The sewing machine speed is set (by hand tach) at 2400 RPM or 2400 stitches per minute. The number of stitches desired is 8 stitchs per inch. The total length of sew path is determined by the size of facing, but is, of course, a constant for each given size.

C. Assuming as per Figure 1:

AB = 2 inches

BC (along the curve) = 1/4 (2 OB) = 1/4 (2 x 3.14 x 4) = 6.28".

CD = 3 inches

Total Path = 2 + 6.28 + 3 = 11.28"

Total Path = 11.28 x 8 = 90.24 stitches

An electrical tachometer generator mounted to the sewing head and geared to its handwheel is rated to produce 2.5 volts/1000 RPM or 2.5 volts/1000 st/min since each revolution of the handwheel is equal to one stitch. Each stitch, therefore, is represented by

$$\frac{2.5 \text{ volts}}{1000 \text{ STS}} = .0025 \text{ volts/stitch/min}$$

Three voltages are required to fix the length of the two straight and one curved sewing path. These three distinct voltages are set by means of potentiometers on what are termed integrator cards. The integrator accepts the rate output of its

TYPICAL JEANS FACING STITCH PATH

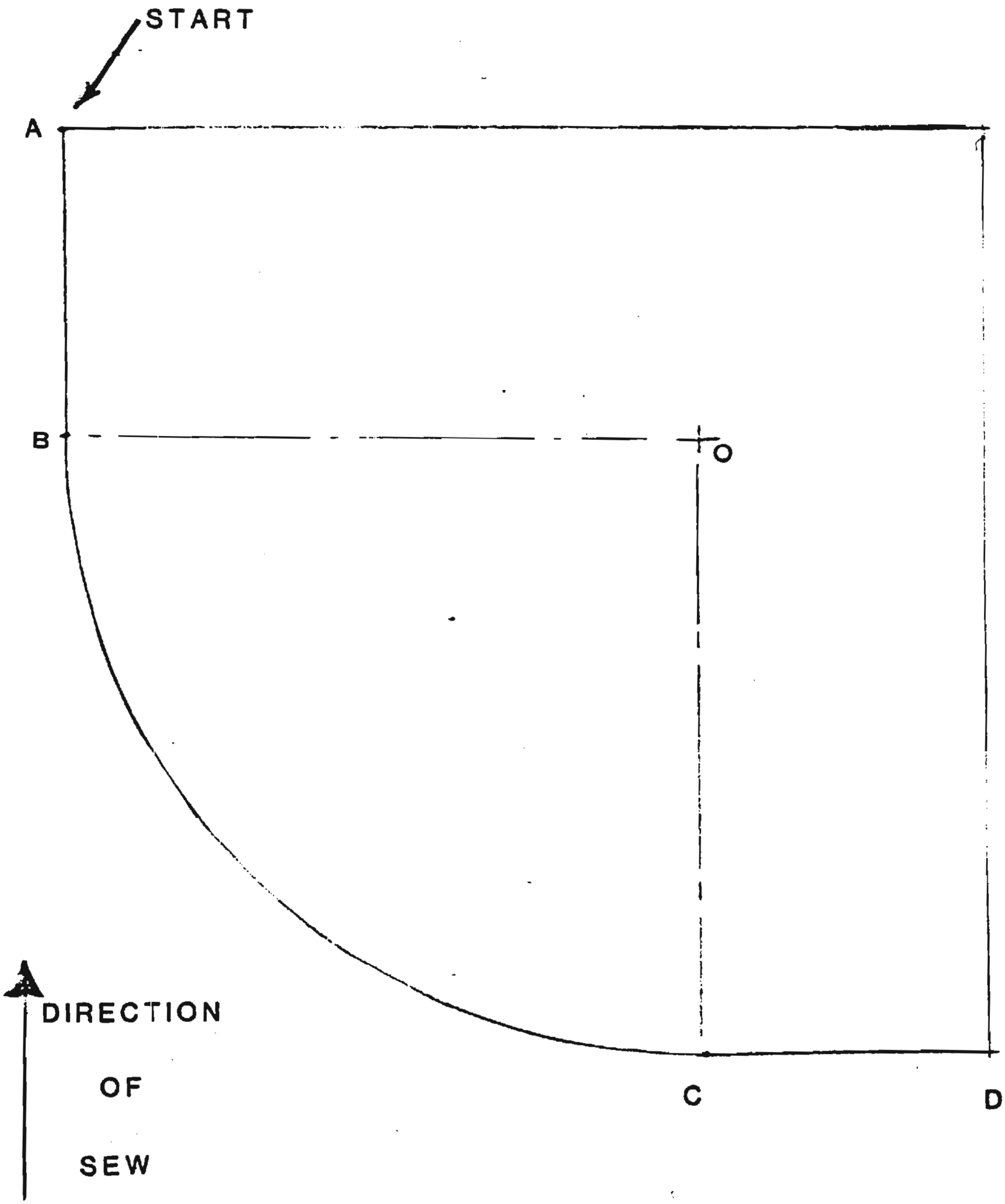


FIGURE C-1

tachometer generator and mathematically integrates the rate to obtain a distance measurement. The integrated rate is constantly compared to the preset value. When the two values are equal, a relay (or transistor as the case may be) is then energized which causes the machine to follow a different set of instructions. The machine contains three D.C. servo drive systems which follow the instructions from the tach generator and respective integrators. Two servos drive in a linear motion and one drives in a rotary motion. As previously shown, the desired path consists of a straight line meeting tangentially to an arc of a circle and then back again (after approximately 90^{0} rotation) to a straight line.

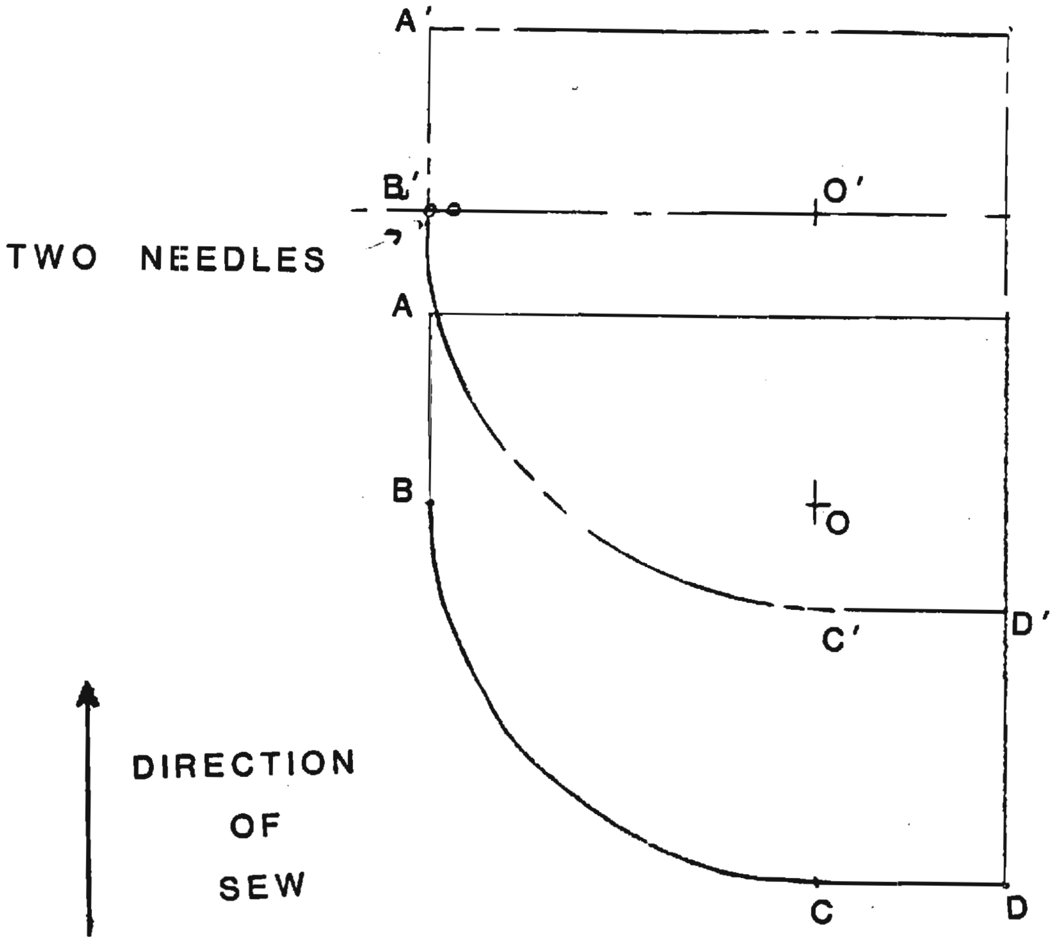
The values of AB, BC and CD are set on the respective numbered dials for each integrator card. Once the facing is in the proper position on top of the lining and in the proper linear orientation to the sew-line the cycle is initiated by a start signal. Actuation of the cycle start will cause the clutch on the sewing machine drive motor to engage and the belts to begin driving the cloth through the machine. When the sewing machine starts to turn, its tach generator will begin to emit a signal. This signal will start the linear D.C. servo drive to follow. The pocket and the lining to be sewn will then proceed to be driven past the needle in a straight line by the feed dog and parallel drive belt. When the point O' (refer to Fig. 6-2) coincides with point O (the fixed center of rotation) the comparison of the integrator controlling the first linear sew will have been accomplished. Satisfaction of the first linear integrator will start the rotary D.C. servo to drive and stop the linear servo (all servos are dynamically braked on stopping). Again, the following of the rotary servo will be monitored and compared to the preset value on the second integrator card. When this condition has been satisfied, the rotary servo will be stopped and the linear servo will be turned on again. The bundle in the meantime, will have been driven through the first linear motion (AB) and then through the rotary motion (BC) and now through the next linear motion (DC) by lifting the pin and dropping the drive belt. The linear servo will follow the instructions from the third integrator card. When the third comparison has been met, all motion will cease. The cutters will then be instructed to clip the threads and the unit will be instructed to return to its starting position to proceed with the next piece.

At the time that the rotary servo is engaged to sew path BC, the pivot-pin which is operated by an air cylinder will descend upon the facing being sewn and establish the center point 'O' for rotation. During the linear sewing portions of the cycle, a small belt drive, also servo driven and following the same tach signals, descends upon the facing. This belt being synchronized with the feed dogs of the sewing machine (by virtue of the tach generator on the sewing head) assures that the facing and lining will drive in a straight parallel line. The belt and pivot pin are lifted and dropped in opposing relationship to each other during the complete cycle.

As previously mentioned, each servo drive has its own tach generator. The sewing machine tach generator provides the signal

ARRANGEMENT OF FIXED ROTATION CENTER O'

AND FACING CENTER O



NOTE: O AND O' WILL COINCIDE AT
THE END OF FIRST
SEW PATH A'B'

FIGURE C-2

input to be followed by all of the other tachometers. The feedback system consequently 'closes' the loop insuring that what has been requested has indeed been accomplished.

It now becomes evident that if a straight line path only was desired, the rotary system would be shut-off, the first linear sew would be pre-set to the proper integrated length, the cutters would be instructed to cut a the end of that sew distance, and the unit would be told to return to its starting position.

In the event two straight paths at a given angle to each other is desired, then the first linear sew would set for its proper distance and the sewing machine would then be told to stop sewing. A signal to the rotary D.C. servo (from a source other than the sewing machine tachometer) would then tell the rotary drive to turn the pocket bundle about the center-line of the needle. At the end of the rotation, the second linear sew would be engaged causing the cloth to again be moved in a straight line for its predetermined distance.

The only other elements in the system are the respective power amplifiers that drive theD.C. motors. These units must accept the low level signal from the servo drive cards and amplify them to the power levels required by the motors. The servo cards in turn control the speeds and directions desired by each of the servo units, as well as the dynamic braking.

One addition to the system will be necessary for a multipurpose workstation. The pivot pin must be provided with a drive system to change the distance between the pin and the sewing machine needle (length OB) so that changes in the radius of curvature can be automatically set by the overall control computer.

APPENDIX D

Bobbin International Inc.
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Manuel Gaetan, Ph.D.
President,
Management Services Group

October 26, 1984

Dr. Wayne Tincher
Georgia Institute of Technology
School of Textile Engineering
Atlanta, Georgia 30332

Dear Wayne:

The purpose of this letter is to share with you my comments regarding the Automatech-Georgia Tech mechanization project.

I can't help but be impressed with the progress which has been achieved to date considering the amount of time and the amount of money that has been spent. This really is what is called getting your bang for your dollar.

There are several features about the equipment which has been developed that are impressive to me:

1. It is a modular concept, thus rendering it very flexible or generic.

2. It is intrinsically generic besides the flexibility that modularity gives it because the system can pick up different kinds of fabric, the system can register different kinds of fabric and it can fold different size pockets (with minimal and quick adjustments in the sensing units).

3. The developer has displayed a tremendous amount of ingenuity in maximizing the mileage that can be obtained from the contract dollars (a car jack to lift the rotating indexer, 35mm film canisters as protectors, coffee cans as lamp shades for the original registration prototype, etc.). This, although it appears insignificant, demonstrates the developer's integrity in ensuring that the contract dollars yield the maximum results in the important functional areas of the machine.

4. The developer is the first one to recognize that what we have here to date is a proof of concept model, advanced enough that it could be considered a prototype.

5. The developer has a firm grasp about the complexities of the problems that are ahead of him and has calculated what would be required to develop a prototype which can be field tested. Beyond that, he also understands what would be involved to move the concept from prototype to commercial unit.

6. The operational logic of the machine is sequential but the initial sewing function can take place while the other modules are running. This means that the speed of the machine is not limited by having to wait for the completion of the full cycle.

7. I am also impressed by the fact that there was some restraint exhibited in developing that machine. By this, I mean that there was more technology that could have been added to the machine, but it would have been unnecessary and for that reason, was not done. For instance, the machine is programmable controlled, instead of computer controlled.

The question that we have to address here now is where do we go from here? Research funds have nearly been exhausted and the project is not completed. Although, it has satisfied the contract requirements (except for factory field testing). To drop this project now would be not only wasteful, but shameful. We are so close to a true technological breakthrough in automation that to not bring it to fruition for the sake of another couple of hundred thousand dollars is a shame. At a time when there are other government projects that are receiving funding, though just as worthwhile, this one deserves immediate attention. Perhaps some funds can be diverted to this particular project or some other mechanism can be employed to bring this one to a point where the first commercial units can be made. This may require that a presentation be made to the highest levels of government policy makers to see what has been accomplished and this could very easily be done using video tapes and making the presentation in Washington to either the Department of Commerce, the Department of Defense, legislators or all of them combined.

I am convinced that, given the proper funding to this developer who has demonstrated the talent and integrity to handle a project of this nature, it will be a success for which our government will have every reason to be proud. At a time when we are concerned with protecting the apparel manufacturer from imports of low-wage countries, I can see no better and worthwhile project than to help an American inventor come up with a machine which can handle a score of operations, in generic parts of the products which, for the most part, are unaffected by fashion changes, thus, rendering it very attractive. To let this project die now due to lack of funding would be unconscionable.

Cordially yours,

Manuel Gaetan, Ph.D.

MG/as

THOMSON COMPANY

Manufacturers and Merchandisers

THOMSON, GEORGIA
30824

November 29, 1984

Dr. Wayne Tincher:
Georgia Institute of Technology
School of Textile Engineering
Atlanta, GA 30332

Dear Dr. Tincher:

This letter is in reference to the October meeting of the Industry Advising Committee on the Automated Trouser Front Pocket Assembly Project. We deeply appreciate the opportunity to provide input into the development of this project. Automatech Industries has been very receptive to suggestions compiled and responsive to problems incurred during our in-plant testing of the first semi-automated prototype.

As of week ending December 7, 1984, we are scheduled to receive and begin in-plant testing of the updated semi-automatic prototype. We are looking forward to this next phase with high expectations.

I am also impressed with the stage philosophy that Automatech has adopted. This philosophy should provide a larger market base by enabling various size apparel firms to phase in automation on a gradual basis.

If I can be of any further assistance, please call.

Very truly yours,

THOMSON COMPANY

Robert E. Brooke

Robert E. Brooke

cc: Gary Hughes
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October 31, 1984

Dear Wayne:

I submit the following after our Industry Advisory Committee meeting at Automatech on the Department of Commerce International Trade Administration Project on automated trouser front pocket assembly.

Firstly, let me say that I feel for the total monies expended, Herman and his group at Automatech have achieved a high degree of success in concept. To be sure that everyone understands, what has been developed is a proof of concept model which means it can be done. This does not mean that what has been done is capable of running in a production environment but it is the necessary first step. And, as I said earlier, has been well done.

Unfortunately at this particular time the jeans business is not in the best of shape but the project should be continued to be funded to

1. Production engineer the unit for manufacturing.
2. Produce a prototype for jeans pockets.
3. Produce a prototype for slacks pockets.
4. Once the prototypes are built, they should be field tested in plants, even if this has to be funded by D.O.C.

During our discussion period, it was brought out that to accomplish items 1 and 2, it would take 6 to 8 months and cost $100,000 to $125,000 to do, and to accomplish #3 above would be 8 to 12 months and cost $125,000 to $175,000.

Given the jeans market as it is, I would suggest applying for an additional grant to go after the slacks first. It would appear to be the largest potential at this time and it is easier to de-engineer to do the jeans pocket than vice-versa.

Georgia Inst. of Technology
October 31, 1984

Also during the discussion it was mentioned that additional orienting tables would be needed as well as Sewbots to do the slack pockets. I also feel that the complete job should be done, attaching facings and bagging the pockets. I know it was mentioned that it would work with any workstation set up. This may be so but until it is tried, one never knows for sure.

As far as the unit being commercially feasible from a payback or ROI standpoint, I'd have to defer to folks like Ken Osborne who is much more familiar with this than I.

There could be many side benefits to the industry from this one unit in the Sewbots, orienting tables, pick up device, etc., but here again I don't think they can just be taken from one and placed in another unit without some real in-depth interfacing but it could be done.

Again, let me say that for the monies expended, much has been accomplished and I feel it would be a shame not to bring it to completion. I strongly recommend that the D.O.C. be approached to continue the funding to complete and test a prototype for slack pockets.

Sincerely,

UNION SPECIAL CORPORATION

Jack Le Tourneur

J. R. LeTourneur,
General Manager
Automated Systems-Marketing

JRL:d

Kurt Salmon Associates, Inc. *management consultants*
400 Colony Square, Atlanta, Georgia 30361 (404) 892-0321 Telex: 810-751-8199

January 7, 1984

Mr. Wayne Tincher
Project Director
Georgia Institute of Technology
School of Textile Engineering
Atlanta, Georgia 30332

Dear Wayne:

Please forgive my tardiness in getting back to you on my impressions of the "Sewbotics" system at Automatech. As has been demonstrated through some commerical purchase of systems modules, you have developed workable prototypes.

As you know, there are literally thousands of devices to sew defined patterns and to remove completed assemblies from the sewing machine. It is the very area where you are applying "sewbotics", i.e., separate, align, feed and combine parts, that the industry must develop economic and reliable machinery if it is to move beyond present productivity levels.

You have demonstrated working conceptual prototypes in all of these areas. I hope that you are able to secure funding to move into plant testing, because in the pragmatic, bottom line world of the apparel industry, only a working plant test will gain acceptance for general use.

Lastly, I would like to congratulate you, Herman, and your associates in giving the taxpayers their "money's worth." You have used ingenuity and experience to come up with practical solutions utilizing off-the-shelf equipment.

Best regards.

Sincerely,

KURT SALMON ASSOCIATES, INC.

Ken

Kenneth R. Osborne
Senior Vice President

KRO/dg

INSIDE R&D®

THE WEEKLY REPORT ON TECHNICAL INNOVATION

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Opportunities for sensor R&D abound if National Research Council report is accurate. It says US lacks sufficient sensing equipment to adequately protect troops against all known chemical and biological weapons. E.g., none of sensors curr... ...ail-able or under development can detect possible biological agen... ...x bac-teria or biologically derived chemicals such as mycot... ...mical sensors depend largely on principles of wet ch... ...of sensing solution and/or take too long ...
.....In place of existing senso... solid state microsensors ... teract with toxi... different ... bo...

Check out this advance in apparel making if you're looking to shave costs to compete with cheap foreign imports. Georgia Tech textile engineering faculty and inventor at a textile machinery maker have linked up under a Dep't. of Commerce contract to build a machine that automatically sews pockets for trousers.....
.....Sounds pretty tame but don't be fooled. It's the first time skilled human operators have been eliminated from this function and replaced by a machine and an unskilled worker who merely sees to it that the machine doesn't run out of goods to sew.....
.....Even more significantly, same basic machine design could lead to multi-purpose automated apparel machine that could sew anything from men's suits to tents. In fact, no so-called limp fabric combining would be beyond its capability.....
.....Machine picks up facings that are the parts of the pocket structure, assembles them, registers them, and then sews them into proper position with "sewbots"—the machine maker's own automatic steel seamstresses. Unit will be displayed at next month's Bobbin Show in Atlanta.....
.....Company is also working on building a low-cost vision system (photocells are used now) to be interfaced with dedicated computer as part of a multi-purpose apparel work station.....
.....Details: Dr. Wayne Tincher, Professor of Textile Engineering, Georgia Institute of Technology, Atlanta, GA 30322; telephone 404-894-2197. Or, Herman Rovin, Automatech Industries, Route 3, PO Box 244, Piedmont, SC 29673.

...ed steers ...als. Feed ...mented steers, compared ...ers..... ...g Administration criteria are met you ...o acids to be on market in two years..... ..., Ohio Agricultural Research and Development Center, ...ephone 216-263-3900.

If you ...ibed any of the low-alcohol beers coming on the market you may be one of the many critics who find that the new beers lack taste. Signal UOP researchers say they have a solution to that and brewers and vintners are listening.....
.....Signal UOP people are applying their membrane expertise to the problem. Here's what they are doing. They've constructed special spiral wound semipermeable membrane that removes only the alcohol, water and carbon dioxide from beer. Concentrate substances that supply beer's taste, aroma and body—hops, barley and fermentation products—are retained in the beer. Concentrated water is later added back to the beer concentrate to obtain brew with desired amount of body. Membrane achieves similar results for low alcohol wines.....
.....Details: Dr. Robert Riley, Director of Research, Fluid Systems Div., Signal UOP Group, 10124 Old Grove Road, San Diego, CA 92131; telephone 619-695-3840.

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New Equipment Exhibited at Trade Shows

by Tom Hopkins

Two major sewn products trade shows (the Industrial Fabrics and Equipment Show in San Francisco last October, and the Bobbin Show in Atlanta last September) recently provided attendees outstanding opportunities to visit suppliers, see demonstrations of new advances in technology, talk about these advances with their peers and take a close look at the present state and the future of manufacturing in their respective industries.

At these shows, it was difficult to find a piece of equipment that was not equipped with, driven or controlled by a computer or microprocessor. In many cases, the dreams of yesterday have become realities. And, according to Lawrence Levine, a consulting engineer for Tech Style Industries, "with some imagination, commitment and communication with suppliers, anything can be done."

A few advancements really stand out as possibilities for industrial fabric products manufacturers. These areas are in computer aided design, robotics, automated sewing systems and heat sealing materials handling.

Robotics

Just a few years ago, when people discussed the possibilities of robotics, that was all there was—possibilities. In recent years, however, advancements in robotics have been made at an incredible rate. In heavy industries like the automotive and steel industries, robotics have moved from mere possibilities to realities and on to practicalities. In these industries, robotics reduce labor costs, minimize risk in hazardous environments and improve quality, speed and reliability of work done.

In the sewn products industry, we're at the point of developing the realities of robotics. Overcoming the major problems of handling a wide variety of limp and difficult to work with fabrics on a single ply basis and positioning the pieces to be joined with repetitive accuracy has been a difficult task. Progress is being made, however, by both traditional sewing manufacturers like Singer, Reece and Boston Machine Works, and also by engineering firms like Clippard Instrument Labs, Herbert Kannegiesser Corp. and Tech Style/Automatech Industries, which are applying robotics technology to sewn product applications.

Two recently developed robotic systems seem to have promise for the sewn products industry. First is the Singer MARS (Manufacturer Applied Robotics Sewing) system series 200. This system, designed for edge sewing of automobile seat pads, sews woven or coated fabrics to a foam backing. It incorporates a computerized robot with memory to pick up and place the two work pieces, a programmable class 300W single needle, two thread chain stitch machine, and end effector designed for the particular application. The system also includes an elevator stacker for disposal and automatic parts indexing for work pieces. With the system up and running, it seems the only labor involved is a person to stack cut pieces to be sewn, both fabric and foam, and one person to move the completed work to the next work station. Though the system did show some bugs with the proper alignment of foam and fabric, Singer is confident that these bugs will be worked out shortly and other applications will open up for the equipment.

A second system has been developed through the combined efforts of Georgia Tech, the Department of Commerce Trade Adjustment Assistance Center and Tech Style/Automatech Industries. The robotic system, originally designed to automatically sew pockets for trousers, performed flawlessly.

Of greater significance, however, according to Herman Robin, president of Tech Style/Automatech Industries, Piedmont, manufacturer of the robot, is that "the same basic machine design should lead to a modular, multipurpose automated system for sewing anything from suits to tents and backpacks. In fact," Robin continues, "no so-called limp fabric combining would be beyond its capacity."

The machine picks up fabric pieces, assembles them, centers or places them in proper position (a process known as registering) and then sews with "sewbots"—the machine maker's own "steel seamstresses." The system's pickup and placement arms and registration tables are modular, so depending on the number of pieces being handled or sewn, more modules can be added or taken away.

Project engineer Lawrence Levine explains that though the pickup device is "a fine advancement on its own, the registration tables are the key to the system." According to Levine, it reduces the exacting tolerances required for placement of the limp fabric by the pickup arm and moves the assembled (not yet sewn) work into place for sewing. "The only labor involved here is to make sure the equipment doesn't run out of goods to sew," Levine says.

Pattern Marking and Grading Systems

All maufacturing firms, whether they manufacture on a high quantity production basis, a multiple product high or low volume job shop basis, or on a pure custom product basis, have something in common—patternmaking. Regardless of the quantity or the shape of the product being manufactured, a pattern must be designed, marked up, laid out and eventually cut.

New developments in pattern design, grading and marker making were shown by four firms at the Bobbin Show: Gerber (Camsco) Garment Technology, Lectra Systems, Texnit Machinery Ltd. and Micro Dynamics.

Although the first automated marking and grading systems were introduced in 1966, it is only in the last 10 years that they have gained acceptance and use in the apparel industry. These systems allow manufacturers to create design sketches of the product, design patterns and grade

Continued on page 94

““Apparel Research Notes””

Published by the Apparel Research Committee of the American Apparel Manufacturers Association

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October 5, 1984

ARC Chairman, Charles S. Gilbert, Summerour & Associates, Inc.
ARC Publications Subcommittee Chairman, Smiley Jones, Atlanta Consulting Associates, Inc.

Apparel Research Notes *is designed to provide apparel manufacturing executives with a quick summary of new technology designed to enhance productivity in our industry.*

The equipment covered in this issue was on display at ... *Bobbin Show. It was not possible to cover all* ... *therefore, only significant innovations* ... *technology were selected.*

This issue of the ...
Warren D...

Sewing Equipment

Techstyles, Inc.

At the 1983 Bobbin Show, Techstyles, Inc. introduced a machine with an automatic sewing cycle to attach facings to jeans pockets. This year, Techstyles has gone a step further and has automated the closing of the pockets as well.

The TFCM 2000 is a microprocessor controlled "Sewbot" than can face, close and stack pockets with the operator required only for loading the component parts. A trouser version of the machine is also available. Production is 15 pockets per minute for jeans and 7½ pockets per minute for trousers.

The machine can be programmed to sew straight line facings with a tuck under, or to do curved facings with an overedge stitch. After the facing is completed, the machine will orient, fold, close and stack the pocket. Rights and lefts can be processed alternately.

The design of the workstation is such that the operator has easy access to the finished product, so that quality inspection and bundle handling are facilitated.

The customer supplies the sewing heads, stand and motor. Techstyles fits the TFCM 2000 and adapts it to the specific need.

Techstyles had benefitted from some limited financial assistance for development of this system from the Department of Commerce via Georgia Tech. An important result of this research and development was exhibited at a Georgia Tech sponsored booth.

Utilizing existing technology and considerable innovative design with basic mechanical components, Techstyles has developed a fully automated manufacturing cell. At the Bobbin Show, this cell was utilized in conjunction with the automatic pocket facing machine; however, the concept would certainly not be limited to this application.

"Sewbots" are the heart of the system and are used to pick up and/or move the pieces as required. They are D.C. motor driven devices which utilize a series of switches to slow down and stop the contact point at the proper location. These sewbots have three degrees of freedom in which they can move: horizontal, vertical and rotational in the horizontal plane.

Basically, the unit operates as follows:

- A "slicker picker" is utilized to separate the top ply from a stack of cut parts. This will leave the top ply loose while holding the balance of the stack in place. The actual demonstration model utilized this concept for the cut pocketing material only; however, it could be used for the facings as well.
- The first of the "sewbots" will then move the top ply from this initial point onto the Registration Plate. This is done through the use of both suction and friction at the point of contact.
- The Registration Plate is a clear transparent plate which is driven by three servos and can be manipulated in the horizontal plane such that three photoelectric cells are satisfied. This orients the piece of fabric properly.
- The second "sewbot" will pick up the piece of pocket through the use of suction and move it to the Combiner where it will be placed in registration with the pocket facing. The same sequence of operations and orientation would be used to present the facing to the combiner through the use of sewbots.
- At the combiner, another sewbot contacts the pocket and facing and, utilizing pressure and friction, slides the assembly to the sewing needle.

By integrating the Sewbotic system with the automated pocket operation described previously, it is possible to create a fully automated manufacturing cell

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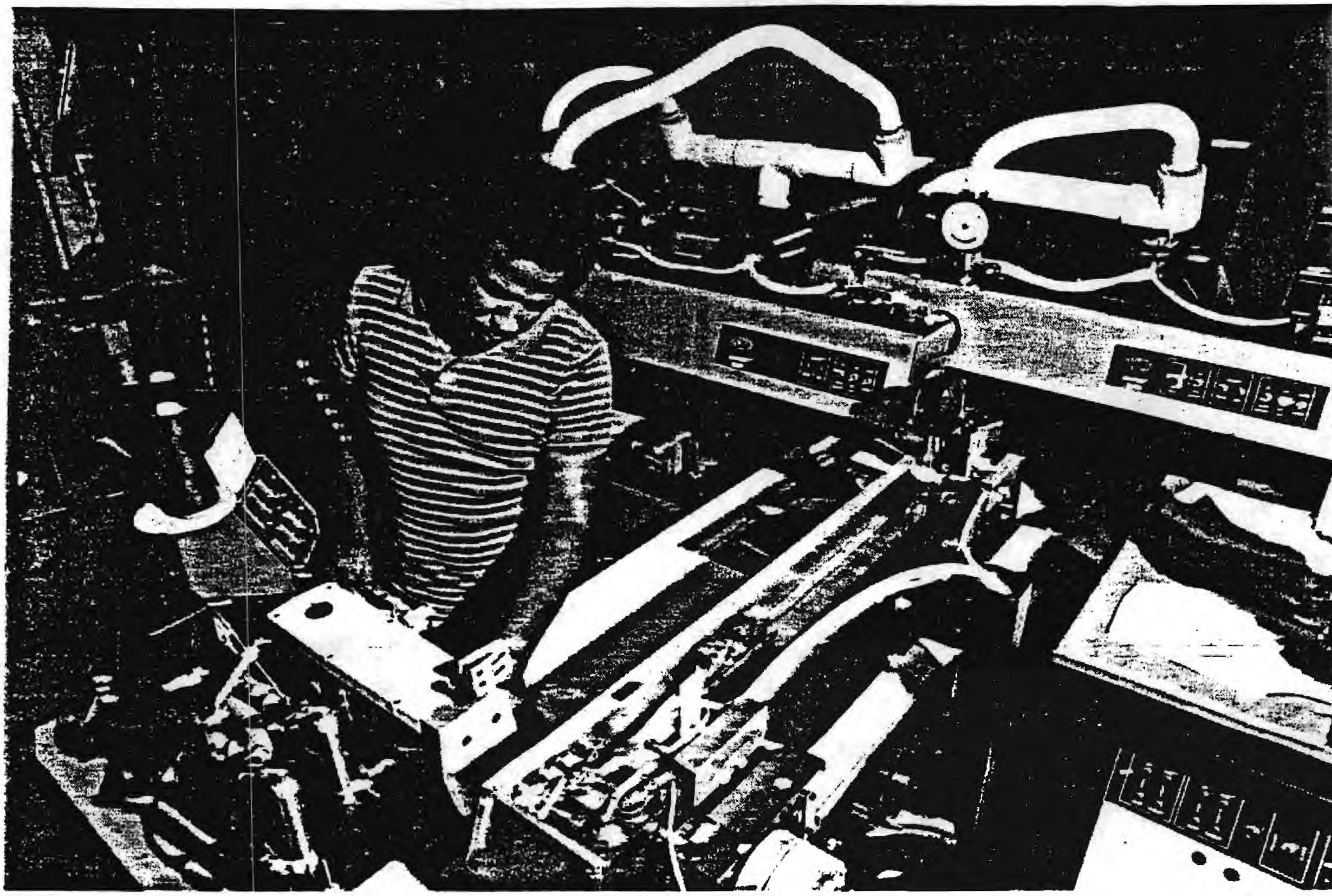
a ... w ... wo ... I. ... mus ... dete. ... neare ... desire ... This fe ... the tab. ... With ... possibili ... evaluate the ... wise to fo ... small amount length- ... to fall into a hole in the marker. This optio ... ay limit the amount of fabric to be wasted to a few inches.

Finally, the third option would determine if a piece of scrap could be cut and used to cover the defect. It

... marker ... save time because ... up" the marker faster ... it from scratch. Additionally, some ... may be "good enough" and so would be used with no changes.

3-D Design. Gerber also showed a three dimensional design package for the first time. Although still in a prototype stage, when available this package will allow a pattern maker or designer to evaluate fit and appearance on the screen. "3-D" grading would also be possible. In the final step, the 3-D design would be "unwrapped" and flat patterns would be generated.



— Darrel Ellis

Techstyle engineer Dennis Rice puts finishing touches on the Sewbot

Sewbot

Sewing robot means more automation for apparel industry

A Powdersville machinery company this ;veek unveiled a prototype sewing robot :hat one day could replace thousands of ;vorkers in the apparel industry.

Called the Sewbot, the machine was de- /eloped at Techstyle Inc., a small company n Anderson County just over the Green- ville County line. The machine picks up two)ieces of cloth with pincers, moves them nto position to be sewn together and per- orms two sewing operations.

It is on display at the annual Bobbin ;how going on in Atlanta through Friday.

Manuel Gaetan, vice president of the ;roup sponsoring the show, said Techstyle vas the only one of 600 exhibitors display- ng a sewing robot that functions without :n operator.

"They are at the leading edge, no ques- ion about it," he said. It's an important in- iovation because it can perform many ypes of sewing operations, he said.

In an interview before leaving for Atlan- a, Techstyle President Herman Rovin said ngineers at his company developed the

By
Betsy Teter
Piedmont staff reporter

about going to the bathroom, doesn't need union holidays and doesn't need health insurance," he said.

It also replaces about eight workers and operates at twice the rate a human can.

Levi Strauss Co. has placed a tentative order for 36 fully automatic Sewbot machines, he said.

"Will it take jobs away from people? Yes," Rovin said. "But if this doesn't, the Japanese and Haitians will.".

Both those countries have growing apparel industries that have been blamed for taking American jobs. Workers in such places as Haiti and Mexico are paid only a fraction of what American workers are paid.

countries.

But exhibiting the Sewbot is just the first step toward getting it in place in apparel-making businesses, Rovin said.

First, the machine must be field-tested in a plant to make sure it works correctly. Then Techstyle, a former Connecticut company of 14 employees, must gear up for mass production by hiring more people, he said.

"We built an airplane. Now we're trying to fly it," he said.

The machine on exhibit puts together two pieces of cloth to form a pocket and performs facing and bagging. The Sewbots and "Slicker Pickers" — the pick-and-place arms of the machine — can be modified to perform many other sewing operations, Gaetan said.

They also can be placed end to end to perform a long series of sewing operations.

"It has a tremendous amount of use," said Gaetan, who is also associate publisher of Bobbin Magazine, a Columbia-based publication.

Client

Thomaston Times

Name of Georgia Newspaper

AUG 22 1984

Date

Georgia Tech To Unveil Automated Apparel Machine In September

Imports have hit the U.S. apparel industry hard in the last few years, but American companies soon may have a way to fight back.

Georgia Tech has worked with Greenville, S.C., manufacturer to build a machine which automatically sews pockets for trousers.

It is the first time the human operator has been removed from this highly labor intensive process. Textile researchers at Georgia Tech believe the same basic design can lead to a multi-purpose automated apparel machine.

"The long term survival of the American apparel industry probably depends on automation," said Dr. Wayne Tincher, a Georgia Tech Textile Engineering professor. "Importers sold around $8 billion of apparel goods in this country in 1982. That's around 30 percent of the market."

The International Trade Administration of the U.S. Department of Commerce has been concerned about this trend, so much so that it funded a Georgia Tech research effort to develop hardware to reduce production costs for American apparel manufacturers. A team, headed by Tincher, selected Automatech Industries of Greenville, S.C., to design and build prototype equipment. Tech's School of Textile Engineering has managed the program.

In the first phase of the research project, Automatech built a machine which partially automates the pocket assembly process, leaving the human operator only the task of aligning pieces of fabric to be sewn together. Phase two, which was recently completed, automates even the registration of the cloth.

"This was not a small accomplishment," Tincher said. "Apparel manufacturers work with very tight tolerances. If a seam is even a quarter-inch out of register, then the trousers are seconds. The job was complicated by the fact that trouser pocket seaming varies from style to style, and we had to account for these differences."

Tincher added that it's more difficult for an automated machine to handle soft, limp materials than a hard, clearly defined object. Pieces of fabric often stick together, and one of the principal problems facing Automatech was to make equipment capable of separating one section of cloth in a stack from another.

"In this regard, our problem has been a significant advance," Tincher said. "Mr. Herman Rovin of Automatech designed a device which picks up several fabrics at a time then flips them onto a grated metal surface. This mesh bed catches the top swatch of cloth and holds it as the wheel turns in reverse, returning the unwanted pieces of fabric to the stack."

The machine will be unveiled to the apparel industry at the national Bobbin Show in Atlanta this September. The next phase of the project will be to place one of the machines in an industrial plant setting and make extensive production evaluations.

Later, an effort will begin to apply the basic design for the pocket sewing machine to other apparel assembly processes. For this machine to handle a variety of different sewing tasks automatically, greater computer intelligence will be necessary.

"We'll be investigating a low-cost vision system to be interfaced with a dedicated computer," said Tincher. "It'll look at fabrics to be sewn together, determine the position for the seam and calculate the correction necessary for the machine to remain in registration."

It is likely, he added, that Georgia Tech and Automatech will collaborate in developing this multipurpose apparel work station.

ATLANTA CONSTITUTION
ATLANTA, GEORGIA
SEPT. 17, 1984

Import problem is key topic at Bobbin Show this week

By Bob Deans
Staff Writer

Since man first began wearing pants, pockets have involved handwork. As simple as a pocket is, it has long been impossible to design a machine that has the mechanical dexterity to lay one thin piece of fabric on another and stitch the two together according to a pattern.

Now, however, Georgia Tech textile engineering professor Wayne C. Tincher has invented a machine capable of doing just that. The machine uses its own tiny computer to control with precision the operations involved in selecting two pieces of fabric, positioning them and sewing them together.

The automation of that basic process could save American apparel manufacturers millions of dollars per year in labor costs.

Automation has come to be seen as the great hope of the American apparel industry in its battle against low-cost imports that have grabbed 35 percent of the U.S. apparel and apparel fabric market in recent years. New automated apparel equipment, such as Tincher's automatic pocket stitcher, will be in the spotlight here this week, at the 25th annual Bobbin Show and American Apparel Manufacturers Association Convention.

Some 65 percent of the equipment that will be displayed at this year's Bobbin Show will feature some kind of computerized operation.

The industry's largest annual event, this year's Bobbin Show is expected to draw some 15,000 representatives of the apparel and fabrics industries, as well as some 8,000 sales and support personnel for the 600 companies that will be exhibiting their wares.

The Bobbin Show will be held Tuesday through Friday at the Georgia World Congress Center. The show is geared toward apparel makers as well as manufacturers of upholstery, carpets, soft luggage and footwear, according to Betty Webb, vice president of administration for Bobbin International Inc., the Columbia, S.C., firm that sponsors the show.

DURHAM MORNING HEARLD
DURHAM, NORTH CAROLINA
SEPT. 20, 1984

Sa

Sewing Robot Is Developed By South Carolina Company

POWDERSVILLE, S.C. (AP) — The introduction of a sewing robot developed by an Anderson County machinery company could be a mixed blessing for the textile industry, depending on your point of view.

Textile owners are likely to wet their lips at the prospect of hundreds of prototype sewing robots clicking contentedly away in an apparel factory. But the success of the robot developed by the machinery company could be bad news for textile workers laid off in the process.

CALLED the Sewbot, the machine was developed at Techstyle Inc., a small company in Powdersville. The machine picks up two pieces of cloth with pincers, moves them into position to be sewn together and performs two sewing operations.

The robot is on display at the annual Bobbin Show in Atlanta through Friday. Manuel Gaetan, vice president of the group sponsoring the show, said Techstyle was the only one of 600 exhibitors displaying a sewing robot that functions without an operator.

"They are at the leading edge, no question about it," he said. It's an important innovation because it can perform many types of sewing operations, he said.

TECHSTYLE President Herman Rovin said engineers at his company developed the fully automatic, preprogrammed sewing machine during the last year. He said he hoped his machine would help sustain the apparel industry in the United States by cutting the cost of production.

"It runs three shifts a day, doesn't know about going to the bathroom, doesn't need union holidays and doesn't need health insurance," he said.

The robot also replaces about eight workers and operates at twice the rate a human can.

Levi Strauss Co. has placed a tentative order for 36 fully automatic Sewbot machines, he said.

"Will it take jobs away from people? Yes," Rovin said. "But if this doesn't, the Japanese and Haitians will.".

BUT EXHIBITING the Sewbot is just the first step toward getting it in place in apparel-making businesses, Rovin said.

First, the machine must be field-tested in a plant to make sure it works correctly. Then Techstyle, which was formerly based in Connecticut, must gear up for mass production by hiring more people, he said.

Company officials hope the eventual sale price of each machine will be $50,000 to $100,000.

"We built an airplane," he said. "Now we're trying to fly it."